THE ENGINEER

A Seven-Day Journal

An Atomic Energy School

It has been announced by the Ministry of Supply that an atomic energy school is to be set up at the Atomic Energy Research Establishment at Harwell to teach workers in industrial and medical laboratories how to use radio-active materials. This school is to be opened because of the rapid increase in the use of British radio isotopes, which has led to a widespread demand for further education in the subject. Both medical and industrial workers now wish to learn what can be done with radio isotopes and what apparatus and methods are necessary to deal with radio-active materials. There are also a number of organisations which wish to apply radio isotopes to a specific purpose and need training facilities in these techniques. At the school it will be shown how, contrary to the general belief that elaborate equipment is needed to use radio-active materials as tracer substances, comparatively simple equipments and lay-outs can be used if the proper precautions are taken. Students of graduate level will be given detailed instruction in the fundamental, practical and theoretical problems encountered when radio-active materials are used in the quantities employed in a normal laboratory. In the course of their training the students will learn the methods of handling radio-active materials as they are received from Harwell, and the difference between isotopes of various substances. The measurement of radio activity with a Geiger counter and scaler, the use of scintillation counters, ionisation chambers and photographic methods for radiography and radioautography will be included in the training. The first training course, which will last for six weeks, will begin at Harwell on April 2nd, under Dr. J. E. Johnston, of the establishment's isotope division.

Chair of Electrical Engineering at Cambridge

Among the main post-war requirements of the University of Cambridge, formulated in 1944, was the endowment of a Chair of Electrical Engineering. As there was a possibility that circumstances might prevent the plan being put into force sufficiently quickly after the end of the war, the President and Council of the Institution of Electrical Engineers decided to offer to the University a sum of money, which would provide for the establishment of a Professorship of Electrical Engineering for a limited period of five years, that the Chair might be established without delay pending the completion of arrangements for a perpetual endowment. The offer by the Institution of Electrical Engineers was accepted by the Council of the Senate and the Professorship was established in November, 1944, and assigned to the Faculty of Engineering. As the period of five years stipulated by the Institution of Electrical Engineers expired, the Council of the British Electrical and Allied Manufacturers' Association, recognising the important benefits that the electrical profession and industry derive from the Chair of Electrical Engineering, undertook to raise the money necessary for the permanent endowment of the Chair. Accordingly, the Association asked the University to accept a contribution of £71,000, subscribed by member-firms of the BEAMA. On March 6th the Vice-Chancellor formally conveyed the Senate's acceptance and thanks to representatives of the BEAMA and the Institution of Electrical Engineers. The President of the Association, Sir George Nelson, and the Chairman, Mr. G. Leslie Wates, expressed to the Vice-Chancellor the gratification felt by members of the Association that the Chair of Electrical Engineering would now be permanently endowed and that it would make both full and lasting contributions to the advancement of electrical science and engineering.

Proposed European Rail Tariff System

The working party on railway tariffs set up by the United Nations Economic Commission concluded at a recent meeting that, in order to encourage European trade, international tariffs treating Europe as a single country, with conditions of transport and charges independent of those of internal tariffs, should be recommended. Thirteen governments were represented in the working party, which considered that the establishment of such international tariffs, independent of internal tariffs, would constitute an effective means of developing and facilitating international trade and, would prove of value to the European economy. To achieve this end railways and industries would have to co-operate and, initially, an attempt might be made to establish international tariffs for "less-than-wagon load" consignments. Although the working party was aware of the difficulties which would be involved in setting up international tariffs, it was encouraged by the step made in that direction by Norway, Sweden and Denmark, which had already established such a tariff, shortly to come into operation between the three countries. One of the objectives of the Economic Commission for Europe is to bring about a certain harmonisation of European railway tariff systems. One phase of this work is the development of model tariffs which would be conducive to the establishment in the different countries of tariffs on uniform lines. The E.C.E. tariff's working party, which recently held its second session, hopes at its next session to receive from the International Union of Railways two revised draft model tariffs. One would serve as a basis for international through tariffs and the other as a model for railway systems when revising their internal tariffs.

The Royal Aeronautical Society

The Royal Aeronautical Society has announced that Dr. Archibald Morton Ballantyne, A.F.R.Ae.S., A.M.I.C.E., has been appointed Secretary, in succession to Captain J. Laurence Pritchard, who is retiring from that office. Captain Pritchard, it will be recalled, was editor of the Society's *Journal* from 1919 to 1925, and from that year onwards he has been the Secretary. At the recent Louis Blériot lecture given to the Society, Captain Pritchard was presented with the Medaille de l'Aéronautique by the President of the Association Française des Ingenieurs et Techniciens de l'Aéronautique. This was the first occasion on which the award has been presented to any person in this country. Dr. Ballantyne, who is forty-two, is the Senior Lecturer in the Civil and Municipal Engineering Department of University College, London. He will take up his new duties as Secretary on July 2nd. The Society has also announced this week some details of its annual garden party, which is to be held on Sunday, May 6th, at the White Waltham (near Maidenhead) Aerodrome. It is hoped that the flying programme will include demonstrations of at least two lighter-than-aircraft and some man-lifting Cody kites. Amongst some of the historical aircraft which the Society hopes to exhibit are the Westland-Hill pterodactyl, Sopwith triplane, Sopwith Camel, Bristol Fighter, Avro 504k, S.E.5, Dewoitine D-27, and the Caudron G-3. The flying display will probably include also some helicopters.

Metropolitan Water Board's Annual Report

The annual report of the Metropolitan Water Board for the year ended March 31, 1950, was issued last week. The report gives a great deal of information about the Board's organisation and activities, and is divided into four sections which deal with the constitution of the Board, financial information, sources of supply and statistics relating to supplies and works, and miscellaneous information concerning the Board's undertakings. Several of the subjects of the report, such as the construction of new works, problems of increasing reservoir capacity, the introduction of superchlorination, have been mentioned in these columns from time to time, so that no further mention need be made here. The circumstances of the drought of 1949 are examined in some detail, and it is pointed out that although the drought was not as severe as was experienced in 1921, for example, the amount of water supplied was much greater. The yield from the River Lee is falling, and is the first to be affected by a drought, so that the provision of storage capacity in the Thames Valley has become of greater importance. The Board notes that at the present time the deficiency in storage and the inactivity in reservoir construction cannot be regarded with equanimity. The total quantity of water supplied by the Board during the year was 118,147 million gallons, corresponding to an average of about 324 m.g.d. Some 70¼ per cent of this quantity was derived from the Thames, 10½ per cent from the Lee, and 19 per cent from wells and other sources.

The Professional Engineers Appointments Bureau

The Professional Engineers Appointments Bureau, which was incorporated in 1947, has published this week a report of its activities in 1950. The report says that during the year the number of engineers enrolled on the Register dropped gradually from 541 in January to 409 by the end of December, 87 of the latter total being civil, 207 mechanical and 115 electrical engineers. Total registrations to the end of last year numbered 1947, and the number of notifications of vacancies received was 1111, of which 335 were for civil, 510 for mechanical and 266 for electrical engineers. A considerable proportion of the overseas vacancies were in the Middle and Far East, India and Pakistan, and the Bureau says that some difficulty has been experienced in finding candidates willing to go to those countries. On general matters the report notes that the Bureau's main work has been concerned with engineers already in employment, and comments that the majority of those unemployed were over forty-five. Except under special circumstances, the Bureau's policy has been to refrain from putting engineers forward for posts carrying salaries below the minimum figures shown on their application forms. It was noticeable last year, the report observes, that a large proportion of the engineers on the Register were specifying minimum salaries considerably in excess of those offered by employers when notifying vacancies. Although at present, the Bureau says, the demand for professional engineers exceeds the supply, employers could assist by avoiding any tendency to demand qualifications and experience beyond those actually necessary for their requirements. In this way, it is suggested, a properly assessed salary related to the responsibility of the appointment could be more easily equated to the financial requirements of the candidate.

Manufacture of Deep Drawing Steel*

By R. W. EVANS, M.Met.

No. I

Introduction

NO better introduction to this subject can be quoted than the words of Professor H. W. Swift,[1] who, in his foreword to Dr. Jevons' book on "The Metallurgy of Deep Drawing and Pressing," says :—

"The commercial development of pressing and deep drawing has been so rapid and prodigious that it is difficult to realise that they are amongst the youngest of our industrial arts. The layman is already apt to take their results for granted without pausing to wonder at the metallurgical skill and mechanical technique which have combined to make possible the production at one blow of articles so different as shaving cream tubes and automobile wings. And even the engineering designer is apt to take this skill and technique for granted when he assumes that any shape which he can devise in sheet metal can be produced as a matter of course in the press shop."

Those who are called upon to supply steel for these processes may take particular note of the last paragraph.

Statement of the Problem

In the press shop ultimate results depend on two factors :—(1) The nature of the deep drawing operation, (2) the properties of the blank which must undergo deformation, and both of these factors can have a profound influence on the proportion of rejections.

This article is mainly concerned with the second factor, i.e., the properties of the blank and, in particular, with the steelmaking technique which govern the chemical analysis and ingot structure. It must not be forgotten, however, that subsequent to the steelmaking operation the ingot is stripped, soaked, slabbed, the slab dressed, reheated, hot rolled, coiled, pickled, cold rolled, normalised or annealed, temper rolled, packed and delivered. Most of these operations can have an effect on the deep pressing properties. The steelmaker's job is to deliver to

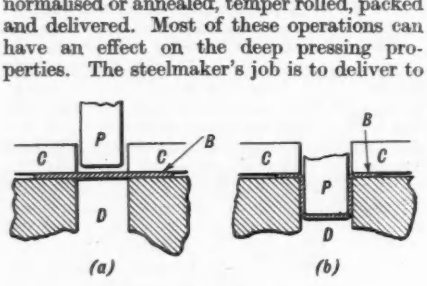


FIG. 1

the soaking pits an ingot which is capable, if properly processed thereafter, of resulting in a satisfactory deep-drawn article.

If the development of this theme appears to err on the side of a steelmaker's defence, it is hoped that deep drawing engineers will at any rate have an insight into some of the difficulties with which steelmakers have to contend.

Historical

On the historical side, Badlam[2] states that cold rolling and drawing in the iron and steel industry probably dates from about 1830, when steel reeds for the use of weavers of Barmen and Hohenlimburg, in Germany, were cold rolled in high-carbon steel. About this time Krupp commenced manufacture of hardened steel rolls for cold rolling. It is interesting to note that originally the chief uses of cold-rolled steel were for wire for ladies' hats, hoops for the old-time hoop skirts, and staves for corsets, also watch springs and shank steel for shoes. The tremendous development in recent years has been well described by J. R. Adams in the 1924 yearbook of the American Iron and Steel Institute.

The Deep Drawing Operation

For a moment let us consider the nature of the deep drawing operation, and the properties of the blank required to meet it.

Fig. 1 gives the simplest presentation of a deep drawing operation, showing the punch *P*, the blank *B*, and the die *D* before the pressing stroke begins. The blank is held in steel clamps or pressure plate *C*. In Fig. 1 (*b*), after the punch has commenced to deform the piece, that part which has suffered plastic deformation becomes work hardened and sufficiently strong to withstand further extension as the punch descends. It then pulls down from the pressure plate and deforms part of the sheet still left, which itself becomes work hardened and stronger than areas which have not yet been deformed. If the process of work hardening did not take place, deep drawing could not be performed, severe necking would occur at the point of initial deformation, and extension would continue at this point of decreasing area till rupture occurred.

The process of drawing is facilitated in practice by the use of lubricants, and by correct contours of punches and dies. However, it will be seen that in a straight drawing operation, as here described at least, the sheet must be uniform in composition and mechanical strength all round, otherwise a localised draw and rupture will take place. The actual pattern of extension during deep drawing can be well demonstrated by scribing a number of parallel straight lines in the form of a grid on the sheet before pressing and noting their relationship after drawing.

Now it is known that there is a limit to the rate at which steel and other metals will work harden so that, if the pressing operation is performed faster than this, rupture will occur. Auto-body sheet pressers are naturally anxious to make as many pressings as possible in eight hours, and their "Grand Inquisitor" is the crank press, which is widely used for auto-body sheet pressings. Jevons,[3] in his standard work on deep drawing, states that, "Considered from both the theoretical and practical aspect, a crank press is a crude and brutal instrument for applying severe stresses to thin sheet metal."

Fig. 2 shows one of its disadvantages from a deep drawing aspect. The harmonic curve

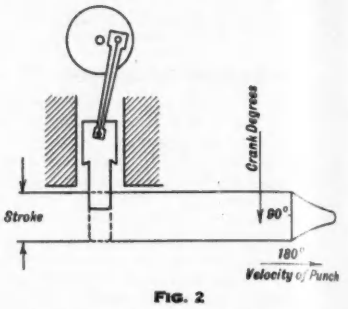


FIG. 2

shows that as the crank revolves from top dead centre the vertical downward velocity of the punch increases, and this becomes accentuated as the stroke is lengthened on those presses which have a variable stroke.

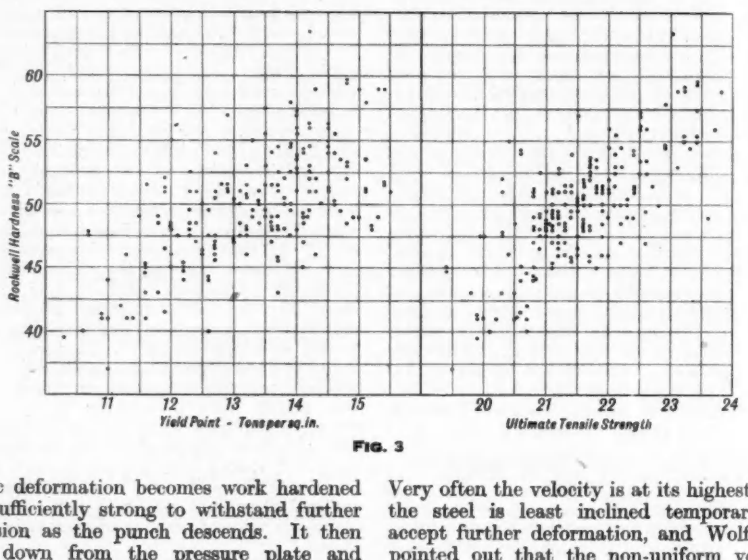


FIG. 3

Very often the velocity is at its highest when the steel is least inclined temporarily to accept further deformation, and Wolfe[4] has pointed out that the non-uniform velocity

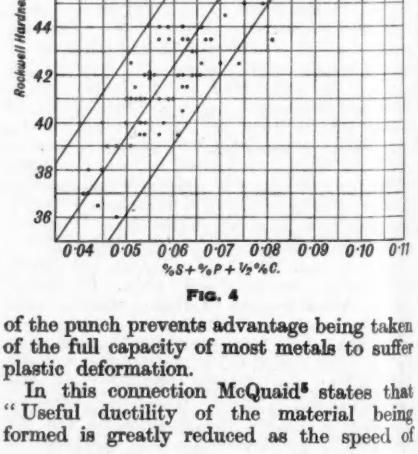


FIG. 4

of the punch prevents advantage being taken of the full capacity of most metals to suffer plastic deformation.

In this connection McQuaid[5] states that "Useful ductility of the material being formed is greatly reduced as the speed of

* This article is based on a lecture delivered to the Swansea Metallurgical Society, March 18, 1950.

loading is increased. In fact, under certain conditions the most ductile of steels will act as absolutely brittle members. In the deep drawing of sheets the load application is often at greater speeds than those of the standard impact test machine, so that what

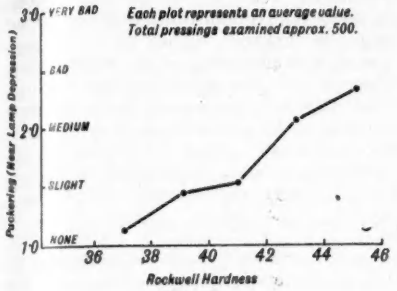


FIG. 5

we think of as a drawing operation is in reality a shock test of high velocity of impact."

These observations are made to show that it is quite possible for a well-made ingot steel to result in a poor pressing. Indeed, if nothing else untoward happens to it, it is liable to age, about which a few words later.

Correlation of Deep Drawing with Other Properties

In general there is no one test which can be used as a satisfactory measure of drawability, and to that extent the process of deep drawing is an art and not a science. It is surprising how little research has been directed to correlating the behaviour of a blank under the press, with its own mechanical properties and chemical composition. As failure under the press is not usually a matter of degree, but is either 100 per cent failure or 100 per cent success, a statistical examination of failure on carefully recorded cast numbers or groups of casts should give the steelmaker and metallurgist much useful information. Customers for deep drawing steel therefore can only supply specifications for their particular draw, which are based on a long and often painful experience; science plays little part in this.

However, the Rockwell hardness test is universally used as some measure of drawability and Fig. 3 shows its relationship to

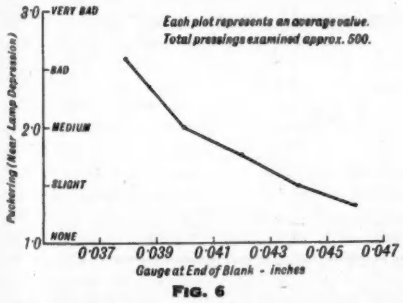


FIG. 6

the yield point and ultimate stress. The yield point is one of the most important properties in a deep drawing steel, because at the yield point plastic deformation and work hardening commence.

In Fig. 4 is shown the relationship between the Rockwell hardness and a combination of the elements sulphur, phosphorus and carbon on the basis of per cent S+per cent P+$\frac{1}{2}$ per cent C. This figure shows that a correlation can be roughly established between composition and Rockwell hardness. Fig. 5 goes as far as any in correlating the deep drawing performance with Rockwell hardness. When a piece fails in the deep draw it does so either by splitting or "puckering," and here is a "best fit" curve for a large number of tests showing the trend of the relationship between failure by "puckering" and Rockwell hardness.

Fig. 6 shows a correlation, based on a large number of tests, between the gauge thickness of the sheet and its tendency to fail by "puckering." Figs. 5 and 6 only indicate the probability of a certain result occurring with a given Rockwell B hardness, assuming all other treatments are the same.

Requirements of the Steel Ingot

Apart from the effects of cold reduction, annealing and temper rolling practice, certain requirements of the steel ingot, which include ingot structure and chemical composition, have been established.

In the first place, rimming steel has been chosen universally as being the most economical way of giving a commercially good

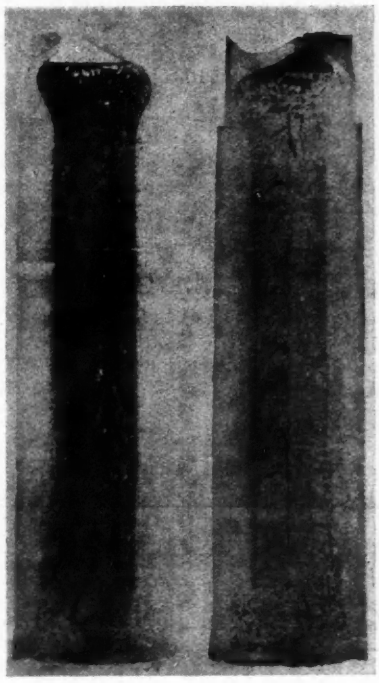
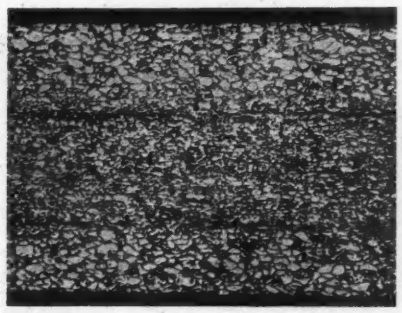


FIG. 7

surface, due to the purity of the rim and its freedom from defects. Such ingots also give a comparatively low loss at the slabbing mill shears, but they segregate to a marked extent. It is necessary, therefore, to keep the segregating elements carbon, sulphur and phosphorus as low as possible to avoid high concentrations at the centre of the ingot. Even with a minimum of these elements the top part of the rimming steel ingot, for the best deep drawing purposes, has to be degraded to a lower quality, owing to the high average content of the segregating elements.

In the ingot it is essential that the skin blowholes shall be sufficiently far below the ingot surface to remain buried after the surface has been partly oxidised off in the soaking pit.

Fig. 7 shows on the left the macrostructure and on the right a sulphur print of a fully rimmed slabbing 9-ton ingot which has practically no skin blowholes and a very well-defined rim. Where the blowholes are revealed during the soaking operation or where, if not actually revealed, the skin becomes so thin that it ruptures easily on rolling, trouble will ensue on the slab surface and edges, which will show as a series of very small cracks or discontinuities, giving the appearance aptly described as "dry." This condition can be rectified only by removing practically the whole surface of the slab by



Microstructure of rimming steel sheet showing relatively pure surface zones and core containing a higher percentage of carbon and impurities (Jevons).

FIG. 8

scarfing, and even then doubts may be cast on the quality. It is a result of too low a state of oxidation of the metal in the mould, which therefore generally rises during rimming and may even overflow the mould. The rise of the steel starts immediately on the completion of pouring and continues for a period, after which the ingot may rim level; it is caused by early formation of blowholes in the ingot skin close to the surface, generally low down, and is a forerunner of trouble.

Fig. 8 shows the relationship of core to rim in the whole thickness of the sheet (×75).

It is good practice to have the steel in the ladle in a slightly over-oxidised condition, i.e., a condition which will tend to produce a sinking rimming action. Small additions of aluminium to the mould then will rectify the condition and cause the steel to rim level, but if the steel tends to rise initially, due to under-oxidation, very little can be done about it. Small additions of sodium fluoride have been recommended, but experience has shown that this has little effect. A small volume of oxygen directed against the stream of metal entering the mould has a definite effect, but it is possible to overdo it.

Therefore the steel must be tapped in a relatively high state of oxidation. If the

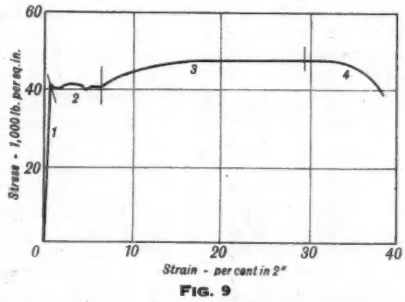


FIG. 9

cast analysis is to finish in the region of 0·06 per cent C and 0·30 per cent Mn, the iron in the slag should not be much below 20 per cent, though this figure depends on other conditions of casting, such as the mould temperature and the height of the ingot to be teemed, also on the temperature of the metal itself.

Due to segregation, the thicker the rim the less pure will be the ingot core. If rimming is allowed to proceed too far the difference in composition will be so marked that on subsequent heating operations there may be rupture at the zone separating the rim and core due to difference in the rates of thermal expansion. The permissible thickness of rim

will depend on the initial purity of the metal and the cross section of the mould; in the author's practice the thickness is about 5in all round.

Mechanically capped steels, made in bottle-

FIG. 10

top moulds to give a thin rim, are rarely used for deep drawing orders.

Much useful and interesting work has been written on rimming steels, but space will only permit the remark that, for the best results, the rimming action—that is, the gas evolution—must be brisk. The uprising bubbles of gas act as a cleanser and sweep out certain impurities with them; these impurities rise as a scum to the top of the ingot, which, in good practice, is skimmed off from time to time as the ingot rims. The bubbles are generally considered to consist of CO, which is relatively insoluble in solid steel and is therefore rejected at the solid/liquid face. The driving force of the reaction is the product of the concentrations of oxygen and carbon; as the carbon is low the oxygen must be high to produce the desired results.

Steel Composition

The deep drawing steel base must be ductile; calculations can be made on the contribution of each element to loss of ductility by assessing the increment of tensile strength brought in by every 0·01 per cent of the element, and a maximum number of pounds per square inch can be fixed, which sets a top limit to the elements collectively. This kind of assessment means that if, for instance, the phosphorus and sulphur are abnormally low, the carbon may be permitted to higher limits. The effect of the tramp elements nickel, copper and tin are important here because, if the steelmaker has regular supplies of pure scrap, in general he can tap on rather higher carbon. Nevertheless, the lower the carbon, sulphur, phosphorus and tramp elements the better. The manganese, however, partly takes care of the sulphur when over a ratio of 10 to 1, and also acts as a preventive of rough edges on the slab and strip, so that it is generally specified at about 0·30 per cent.

A typical analysis specification for best grade deep drawing material is approximately:—

Carbon	0·06 max.
Sulphur	0·03 max.
Phosphorus	0·015 max.
Manganese	0·30–0·35%
Nickel	0·10 max.
Copper	0·10 max.
Tin	0·015 max.

It is difficult to assess the effect of any one element on the drawing properties due to the interfering presence of the others. For instance, very low sulphurs are traditionally held to be a vital necessity, but an eminent American metallurgist with a very large experience of this type of steel has given his opinion that 0·035 per cent sulphur would meet most requirements and that he had been able to find no significant difference between 0·035 per cent and 0·025 per cent either in the slabbing mill or subsequent yields. Yet his firm were regularly producing sulphurs of 0·025 per cent to 0·030 per cent as he admitted, saying that this was a traditional requirement of the pressing industry, and because his competitors were willing to supply it, he had to do likewise.

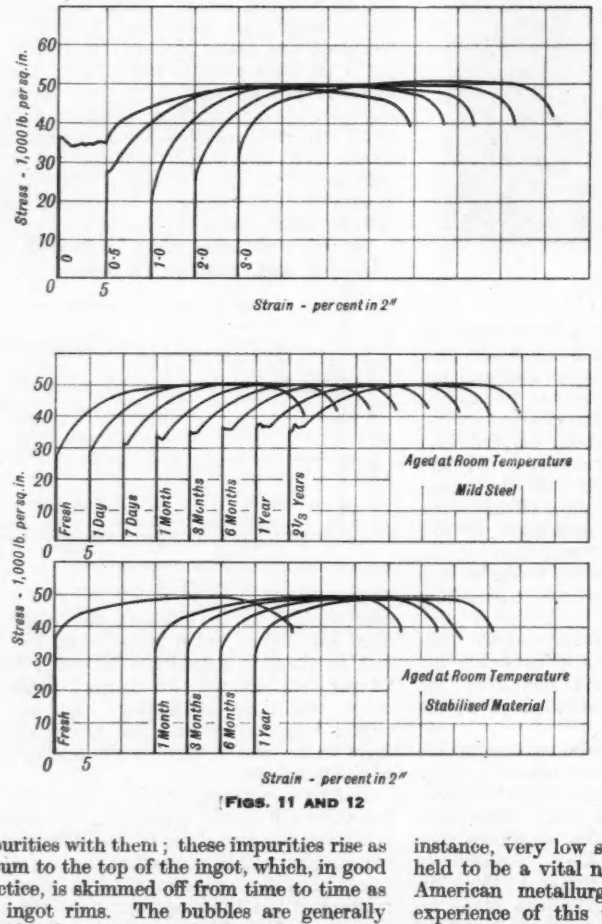
A steel conforming to the above composition should give approximately maximum yield, 23,000 lb per square inch; minimum elongation, 40 per cent on 2in; maximum Rockwell B, 43 (should be obtainable in both longitudinal and transverse directions). Ratio YS/MS not greater than 65 per cent.

Age Hardening

One other factor must be mentioned, and that is the effect of age hardening. After the sheet has been annealed it is in a condition, which, under tensile test, will give a stress strain curve as shown in Fig. 9. After the test piece reaches the yield point a strain called "yield elongation" (shown by section 2 of the diagram) occurs during which period, in deep-drawing operations, "stretcher strains," or Luder lines, appear on the surface of the sheet, which render its surface uneven and unsuitable as shown in Fig. 10. In order to overcome this condition the steel is cold rolled after annealing to give up to 2 per cent reduction, after which the load deformation curve becomes smooth and the yield elongation is eliminated. This is called "temper" or "skin pass" rolling.

Fig. 11 shows the effects of different degrees of temper rolling on the shape of the stress-strain diagrams (Griff, Kenyon and Hayes).

If, however, more than a certain interval of time is allowed to elapse between the temper rolling and deep drawing operation, the interval depending on ambient temperature, hardening takes place and the steel gradually reverts to pre-temper rolling type; the yield point returns and the steel again



FIGS. 11 AND 12

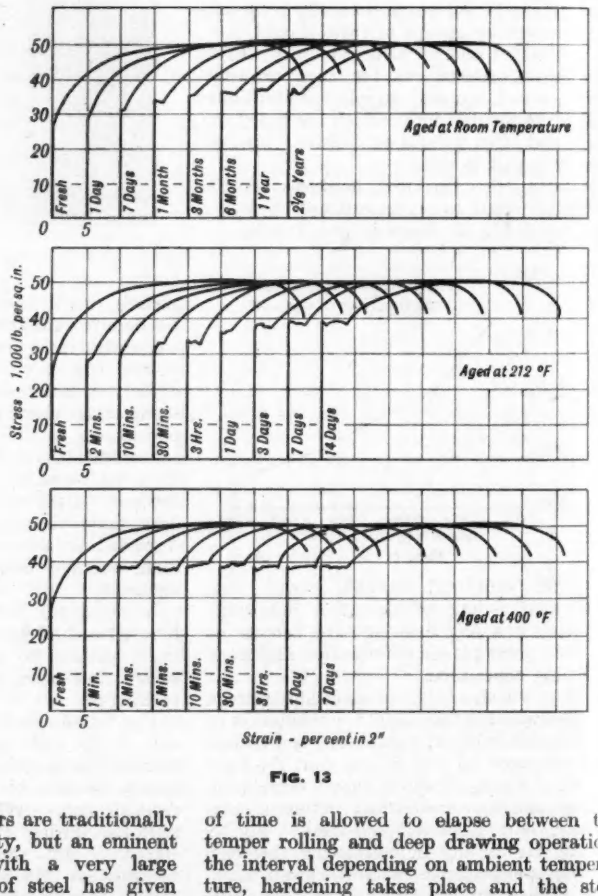


FIG. 13

becomes susceptible to stretcher strains. This phenomenon, the return of the yield point, is called "strain ageing," and to avoid it, even at the atmospheric temperatures which prevail here, sheets have to be dispatched and pressed as soon after temper rolling as possible.

Fig. 13 shows the effect of time and temperature on strain ageing. The cause of the phenomenon is not fully understood, but it may be a gradual precipitation of the very small amount of carbon which is soluble in α iron or ferrite at and just under the Ar_1 point (about 700 deg. Cent.); the precipitation distorts the α lattice and causes hardening of the steel. Precipitation of nitrogen is also thought to have some similar effect; in particular, Fast has carried out valuable experimental work based on the addition of oxygen, nitrogen and carbon to pure iron and subjecting the samples to "ageing" tests. He shows that even 0·001 per cent of nitrogen is sufficient to produce maximum strain ageing, which takes place far more quickly than is the case with carbon, even at room temperatures.

Allowance must be made for this decrease in ductility of the steel sheet during storage by making it that much softer to start with, and this is yet another reason why the amount of hardening elements should be extremely small.

One method of getting over the strain ageing difficulty is to kill the steel with aluminium or titanium. If 3½ lb per ton or more of aluminium are added, it being necessary to add sufficient to enter into solution into the ferrite in addition to that required for deoxidation, the steel becomes commercially non age-hardening, and Fig. 12 gives a comparison between the ageing properties of mild steel and stabilised steel. Such a steel possesses excellent deep drawing properties and, as it is fully killed, once the pipe discard has been taken, the whole of the ingot can be used for the highest grades.

Such aluminium-killed, or stabilised, steels have lower slabbing mill yields, and, in addition, the surface of the slabs as rolled, although appearing excellent to the naked eye, have weaknesses finely dispersed which give rise to shadowy seams on the sheet during pressing. On this account the slabs generally must be completely desurfaced in order to give a good sheet surface after pressing.

As these steels lose no carbon due to rimming, there being no rimming action, they must be tapped at lower carbon than rimming steel.

The addition of small amounts of vanadium to rimming steel, which is the subject of a U.S. patent, is also said to prevent age hardening. In this process the rimming action is preserved with its attendant good surface characteristic.

REFERENCES

[1] Swift, H. W., "The Metallurgy of Deep Drawing and Pressing" (Foreword), by J. D. Jevons.

[2] Badlam, Yearbook of American Iron and Steel Institute, page 352 (1930).

[3] Jevons, J. D., "The Metallurgy of Deep Drawing and Pressing."

[4] Wolfe, K. J. B., "Transactions" of American Society for Metals, Vol. 37, page 3.

[5] McQuaid, H. W., "Transactions" of American Society for Metals, Vol. 37, page 18.

(To be continued)

The "Socialisation" of Industry

(Contributed)

JOHN BUNYAN, a tinker by trade, is rightly held in high honour for the many true and brave things which he has said. Indeed, in such a democracy as ours, great force attaches to the words of a man who combined rare knowledge of the human heart with outstanding gifts as an interpreter. For example, it may be remembered that, in discussing the respective procedures of Passion and Patience, Bunyan concludes that "Passion had not so much reason to laugh at Patience, because he has his good things first, as Patience will have to laugh at Passion, because he had his best things last." This is the sort of "tinker's cuss," which, in these days, we do well to ponder. It should cause men—as it did Bunyan—to avoid the company of "these crazy-headed coxcombs that when they take a fancy by the end, are wiser in their own eyes than seven men that can render a reason." Living as we do in an atmosphere of what are called "unofficial strikes," we can deplore the lack of patience and reflection which is the root cause of so much damage at a time when the nation is faced by threats not only to its standard of living, but to its very existence. Long ago Lord Bacon remarked that "an unadvised haste of assertion, without due and mature suspension of the judgment, is an error of the understanding." His illustrious contemporary, Shakespeare, put this more bluntly in the place where he exclaims:

> "But man, proud man!
> Dress'd in a little brief authority—,
> Most ignorant of what he's most assured,
> His glassy essence,—like an angry ape,
> Plays such fantastic tricks before high heaven,
> As make the angels weep."

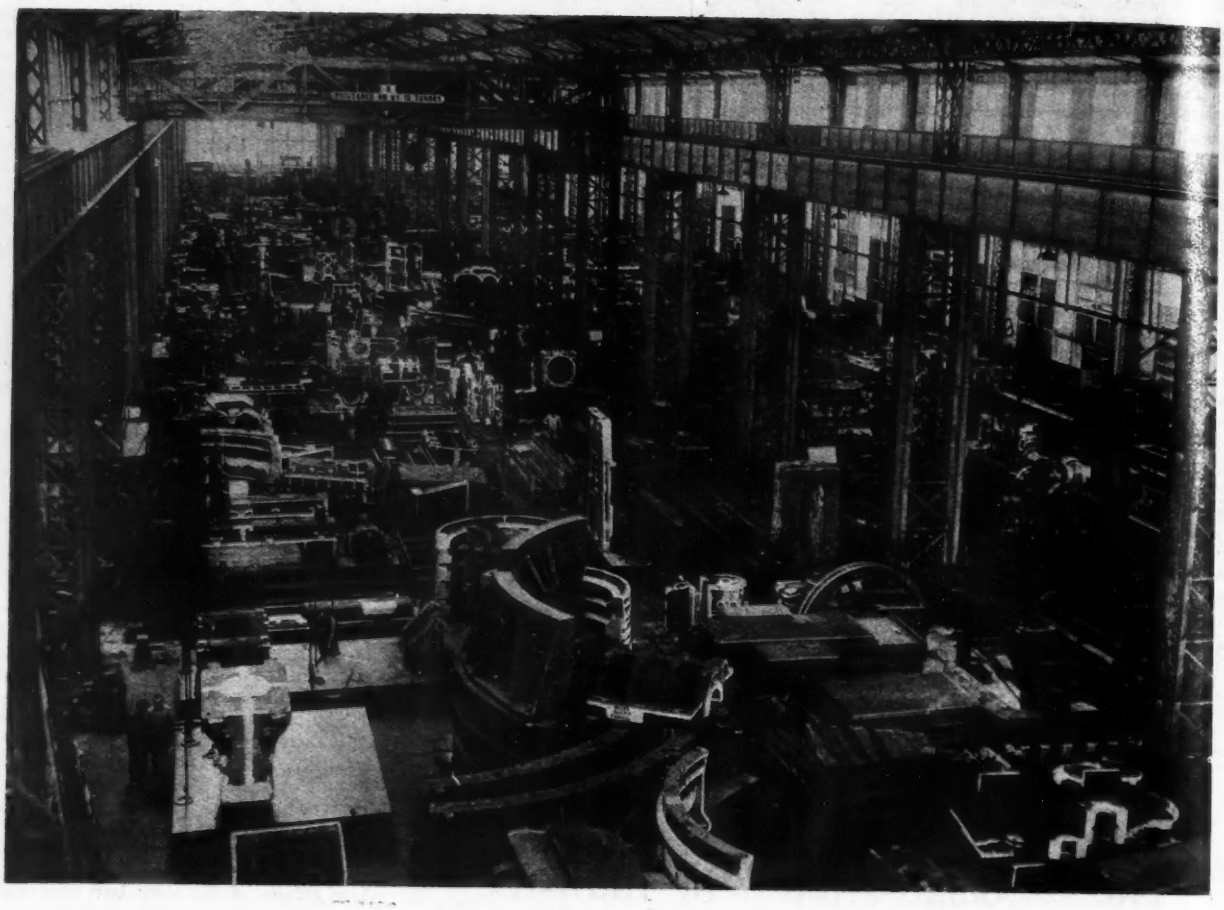
That these tricks are fantastic was brought home to us when, entering a tea shop in the City of London, it was explained that owing to the unofficial strike of certain gas workers, there was no tea, though cold liquids were available. Since the gas industry is now socialised, it seemed an inexplicable thing that innumerable citizens should, on a cold day, be without a hot drink. It could not be said that this was a matter wherein what are called the "people" were being sacrificed for what are called the "well-to-do." It was certainly not the "well-to-do" who had withdrawn their labour regardless of the consequences inflicted on the "people." We mention this as affording an instance of the perils confronting a "Welfare State," in which the Government runs essential industries and thus has to act not only as a government, but as a monopolistic employer.

We have now to face a massive extension of Government monopoly in the enactment of the Bill nationalising the iron and steel industry. If a majority of the enfranchised population of these islands can be alarmed by the sheer recklessness of politicians what are engineers to say about it? The steel industry has been of long growth and its development has been promoted in a singular degree by the intimate relationship which has existed between the industry and its customers. Indeed, the closer this relationship the greater the advantage to the engineering and metallurgical industries and thus to the nation. What can the political fanatic, destitute of industrial experience, know about the interaction of the iron and steel industry with the engineering industry? Can he, for example, be expected to apprehend the significance of the long development of procedures whereby the steel user is able to assist both himself and the steel maker by mutual consultation as to such matters as rolling programmes? Instead of the steel industry standing like a pyramid on its base, supported by its innumerable customers, it is now to be thrown over on to its apex, with its base in the air. Well may the *New York Times* point out that by this foolish act "the whole British economic structure is going to be shaken." The lamentable thing is that this reckless adventure is fraught with danger not only to the nation, but to the men who work in the industry; men whose labours in the past have earned the applause of all. Whether the sons of Vulcan will relish the idea of entrusting their future to the direction of a committee such as the one now advertised as a governing body is something yet to be revealed. The steel industry is peculiarly dependent upon highly skilled craftsmen. "Only he who knows is able to lead," and leadership except by men who have grown up in the industry and proved themselves therein is not going to be leadership of the kind which gains the respect and support of the craftsman. British steel workers will not relish the sort of political leadership operating in the Czechoslovak Iron and Steel Corporation. They are not blind to the dangers of having their livelihood prejudiced by political experiments and what they want is leadership which will stimulate that prosperity on which alone the standard of living can be sustained and improved.

The introduction of the hot air blast was of immense consequence in the iron and steel industry. We are now in peril from political hot air at a time when there is clamant need for avoiding risks and for encouraging and combining all procedures likely to contribute to the prosperity of our metallurgical and engineering activities. We want the very best efforts of the very best men and the greatest possible encouragement for individual initiative. What sane man can be blind to the significance of such instances as are illustrated in the lives, for example, of Abraham Darby, John Roebuck and John Wilkinson? Where would Great Britain have been—as an iron and steel-making country—without the unfettered labours of these altogether exceptional men and others like them? We hear far too much about what is called government by the plain people. A contemporary American writer—Walter Lippmann—has declared that "there is a myth and legend that the 'plain people' like mediocre men in their government. This is a politicians' fable. The cult of mediocrity, which is a form of inverted snobbery, is not democracy. It is one of the diseases of democracy." That politics and Government should have become the departments in which inexperienced innovators are most prone to set aside the experience of the past is one of the major tragedies of our time. A builder of machines will not introduce a new model until he has tested the prototype. A politician, on the other hand, will propose a revolutionary change in spite of the fact that history may be littered with the debris of prototypes which have proved disastrous failures. Never has the debris been piled so high as it is at present, and there is urgent need for the exercise of that wise resolution of Abraham Lincoln to adopt new views "only so fast as they shall appear to be true views."

LIFT OPERATION.—An interesting and well-illustrated brochure has been published by Marryat and Scott, Ltd., Wellington Road South, Hounslow, Middlesex, entitled "What Happens When You Press the Lift Push." It describes in a graphic way the design, construction and operation of lifts.

THE CREUSOT WORKS OF MESSRS. SCHNEIDER



LE BREUIL HEAVY MACHINE SHOPS

HENRI-PAUL FOUNDRY

Activities of the Creusot Works of Messrs. Schneider

(By a Correspondent)

THE manifold activities which are noticeable in every establishment of the Creusot works of Messrs. Schneider are yet another evidence of the endeavours of the French people to restore the damage sustained during the war and not only to rebuild but also to improve and modernise, if possible, the economic and technical wealth of their country.

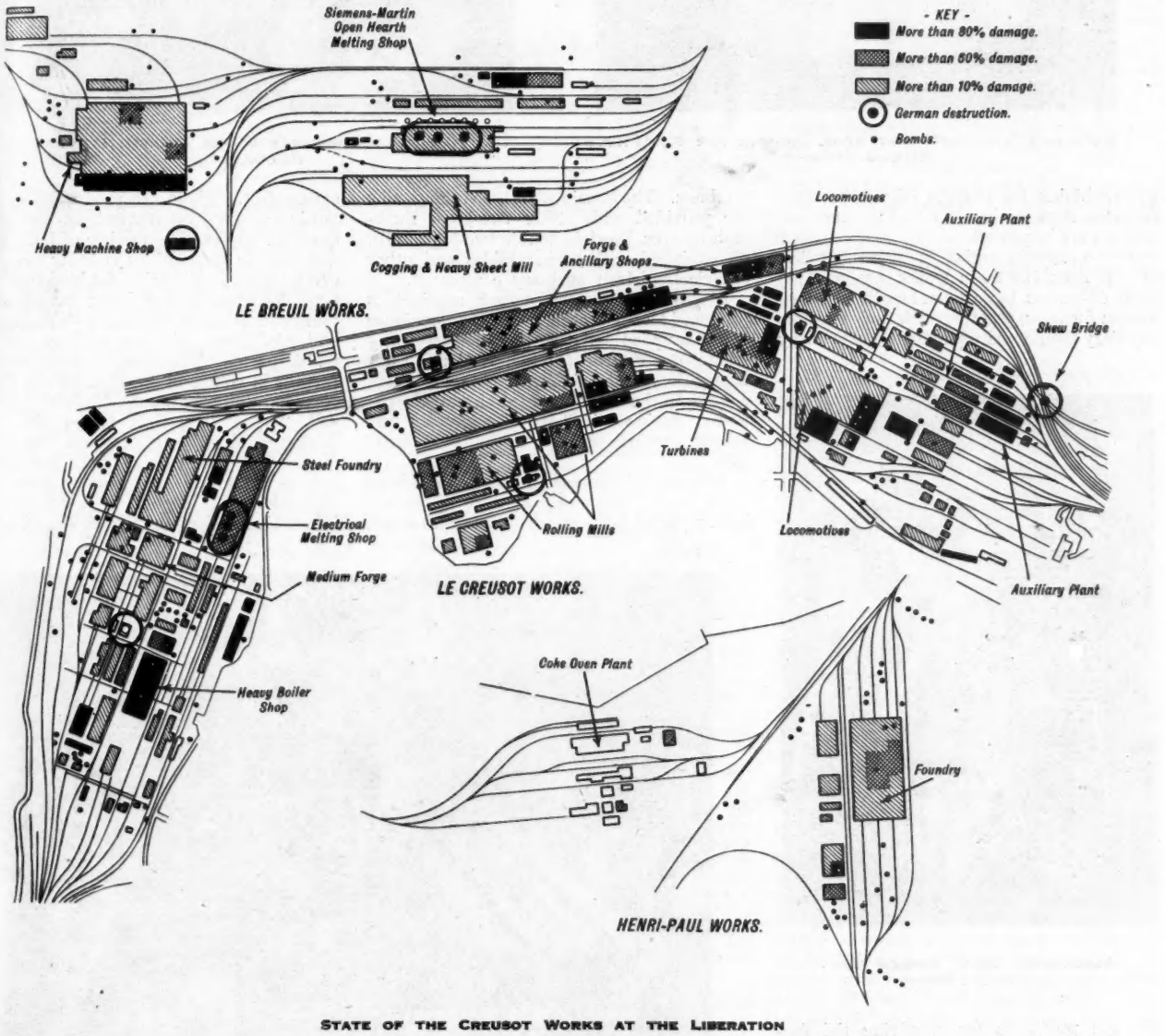
While it is true to say that Le Creusot has been a seat of industry for more than 150 years, its present fame is the successful result of the care and attention paid to its development by the successive members of a single family, which settled in the district after the Napoleonic Wars. At that time, in addition to the collieries at Montchanin and at Monceau-les-Mines, which are still being worked to-day, iron ore was extracted from other mines close by, which became exhausted at the beginning of the present century. Le Creusot, about half-way between these two centres of essential raw materials thus enjoyed conditions which could not but favour the rise and the development of a prosperous iron and steel industry. Intimately interconnected and linked with one another, the township and the works appear more like partners in a common enterprise and each of them derives its due reward of pride and satisfaction from work well done and joint participation both in prosperity and adversity.

Thus it would be difficult to say which of the two suffered more during the last war. Terrible damage, of which there is still abundant evidence, was wreaked by two air attacks on October 17, 1942, and June 20, 1943. Before their departure, the Germans attempted on September 6 and 7, 1944, to destroy systematically the different centres of production but the rapid advance of the Allied forces prevented them from carrying out this project in all its phases. The accompanying plans show the extent of the damage and indicate the number of bombs which fell.

Originally the factory comprised 600 buildings covering some 650,000 square metres of land. At the Liberation 497 buildings, covering 605,000 square metres, were in a badly damaged condition or totally destroyed. Plant and equipment either severely damaged or destroyed included three electric furnaces of 8–10 tonnes; three Siemens-Martin open-hearth furnaces; two transformer stations; three distribution substations; the Chanliau skew bridge; the heavy forge; 700 machine tools; 300 lifting and handling appliances; more than 2 miles of railway track; over 150 miles of various service conduits, and 45,000 casting patterns.

Nothing remains to-day of the old blast furnaces and of the famous 100-tonnes steam hammer. The area of the former blast furnace plant is now taken up by a battery of electric arc furnaces of 10, 8 and 5 tonnes, together with a high-frequency induction furnace of 3 tonnes capacity.

On the other side of a yard, in a building parallel with and opposite to the electric melting shop, is the steel foundry, where it is possible to cast steel castings of up to 20 and 25 tons unit weight, such as runner



STATE OF THE CREUSOT WORKS AT THE LIBERATION

wheels for Francis turbines, or to produce on mass production lines intricate steel castings such as manganese steel crossings and points (Hadfield process). Steel castings exceeding 25 tonnes in weight are produced at Le Breuil from open-hearth melted steel and, by combining the charges of two or more furnaces, steel castings up to 150 tons unit weight may be poured.

At Le Breuil, which is about 3 miles distant from the main works, are situated eight 60-tonnes basic open-hearth Siemens-Martin furnaces, together with their multiple auxiliary plants and equipment, particularly the gas producers for supplying the furnaces with fuel. The space between the open-hearth melting shop and the gas producers is available for stocking raw materials, particularly scrap, with which the furnaces are exclusively charged.

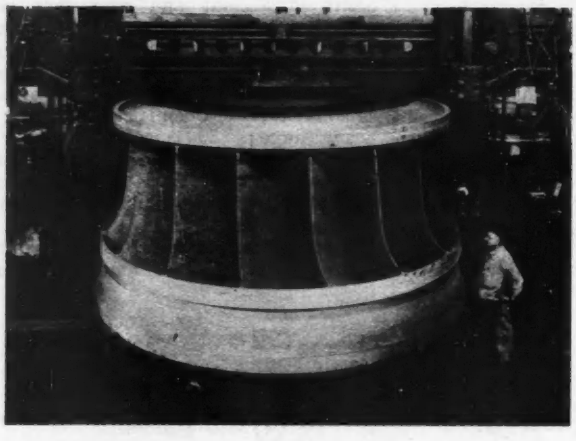
The Germans destroyed three out of the eight 60-tonnes open hearth Siemens-Martin furnaces available before the war. Two have since been repaired but as one of the furnaces is always kept in reserve, only five are at present in service. In the vicinity of and running parallel with the open-hearth melting shop are the cogging and blooming mills, where the cast ingots are rolled into blooms, slabs, billets and large flats. From the Breuil plant these semi-finished products are transferred to the rolling mills for sections, bars, thin sheets and other finished products. The housings of these rolling mills are provided with either two-high, three-high or even Dowlais double two-high mills, all equipped with tilting tables and other electrically-driven ancillary equipment.

Part of the electric power required is produced locally by the works, the remainder being supplied by the nationalised Electricité de France (French National Electricity Board) who, following nationalisation, acquired the works-owned hydro-electric power station of Chancy-Pougny on the Rhône, immediately below the Swiss frontier.

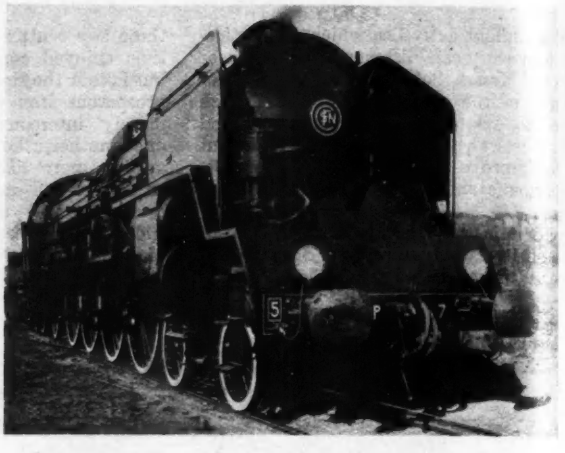
Adjacent to the rolling mill is the heavy forge plant. The steam hammer of old has been replaced by electro-hydraulic and steam power presses of 6000, 4500 and 1200 tonnes pressure, together with a 12,000 tonnes shaping press for thick sheets and similar materials. The same shop is also provided with a pit containing a vertical heat treatment furnace for treating forgings up to 82ft in length, together with a 28ft deep well for water quenching the heat-treated items.

Alongside these two last shops are the turbine and locomotive assembly shops, the combined areas of which exceed 860,000 square feet. While the production of locomotives has not yet reached pre-war figures, quite an appreciable number of both steam and electric locomotives is being assembled every year. Electric double-bogie B-B type locomotives are being manufactured jointly with the firms Schneider-Westinghouse and Als-Thom, who are making the electrical parts. The steam locomotives at present in course of erection for the French National Railways are the "141 P" (2-8-2) and "241 P" (4-8-2) types, the latter having been entirely designed and manufactured on the basis of plans and specifications drawn up by Messrs. Schneider's themselves. It should be noted that the locomotive boilers are not produced at the Creusot works, but in the Schneider boiler and steel fabricating shops at Châlon-sur-Saône.

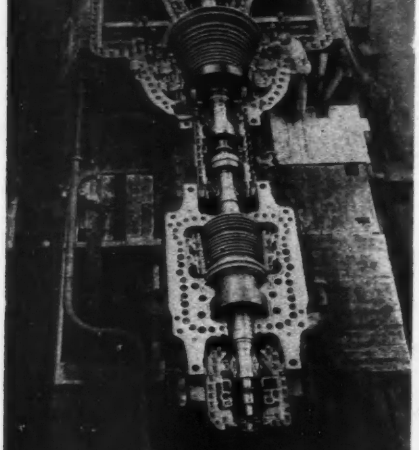
In addition to the open-hearth Siemens-Martin furnaces and other plant described above, the Breuil works also include a large



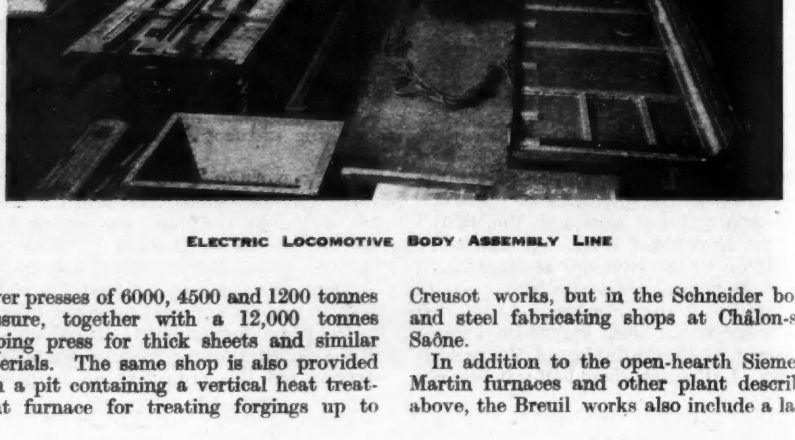
MACHINING STAINLESS CAST STEEL RUNNER FOR 90,000 H.P. FRANCIS TURBINE



"241 P" LOCOMOTIVE FOR THE FRENCH NATIONAL RAILWAYS



ASSEMBLING 40MW TANDEM TWO-STAGE TURBINE



ELECTRIC LOCOMOTIVE BODY ASSEMBLY LINE

modern machine shop of some 540,000 square feet covered area, subdivided in several parallel bays, having a common head bay, which is used for testing fully assembled heavy marine diesel engines (Burmeister and Wain licences), fluid and gas pumps, turbines and other heavy engineering products of all kinds under actual service conditions.

The rails for the travelling crane in this head bay are carried between the end supports of the different cross bays by reinforced concrete bow-string arches, built into the outside wall on the opposite side of the head bay, an arrangement of rather striking appearance and decidedly novel in character.

The layout of this machine shop has been recently modified and the material is no longer distributed according to the type of manufacture called for, but according to the type of machine on which it is to be machined. Each bay contains all available machine tools of any given type, such as lathes, planing and shaping machines, milling machines and drilling machines.

At the Henri-Paul works the foundry has now a productive capacity of about 20,000 tonnes of castings per year.

This brief summary can only provide a mere indication of the vast range of manufacture covered by the different units of the Creusot works, as well as of the task which faced and was accomplished by all the members of the staff of whatever grade or rank to bring the plant back into service after the turmoil they had suffered during the war, so that they might once again contribute to the common effort of the whole country.

High Temperature Steels and Alloys for Gas Turbines

IRON AND STEEL INSTITUTE

No. I

A SYMPOSIUM on High-Temperature Steels and Alloys for Gas Turbines was held by the Iron and Steel Institute on Wednesday and Thursday, February 21 and 22, 1951, in the Lecture Theatre of the Institution of Civil Engineers, Great George Street, London, S.W.1.

In opening the meeting, Sir Andrew McCance (Past-President) said that the subject of the symposium was one of vital importance. Owing to the scarcity and increasing cost of fuel, engineering minds had been turning to the development of machines and engines that would give a higher thermal efficiency. For that purpose they were thinking of regions of temperature in which difficulties in connection with the materials were showing themselves only too clearly. The object of the symposium was to discuss such problems, many of which were highly complex and intricate. Mr. D. A. Oliver (Chairman of the Symposium Organising Committee) took the chair throughout the subsequent proceedings. He said that it was hoped to present, at the symposium, a comprehensive picture of the British effort, and, although it had not been found possible to include papers from authors in other countries, comment and criticism from the forty or more overseas visitors, whose approach to the subject might differ from our own, would be specially welcome.

Dr. N. P. Allen (National Physical Laboratory), in an introductory paper, summarised the development of creep-resisting alloys in the period between the two wars and gave a rather more detailed account of the general trend of the researches undertaken after 1939 in Great Britain, America and Germany to provide improved materials for use in gas turbines. He directed attention to the stage reached at the end of the war, when emphasis had been almost entirely on short-lived engines for aircraft, and remarked that the creep-resisting alloys developed in haste for this purpose were frequently proving valuable in engines of larger size and longer life.

The other thirty-six papers were classified in groups, the papers of each group being presented collectively for discussion. The subject at the morning session on February 21st was "Supplier Aspects," as dealt with in Group III, which consisted of the following papers.

NICKEL-CHROMIUM-TITANIUM ALLOYS OF THE NIMONIC 80 TYPE.

By L. B. Pfeil, N. P. Allen and C. G. Conway.

An account is given of the nickel-chromium base alloys, which, in 1939, provided a background for the development of alloys required to operate at the high temperatures and stresses involved in gas turbine service, of their modification by small additions of other elements, their heat-treatment and high-temperature properties. The work described resulted in the development of Nimonic 80. The properties of Nimonic 80 and 80A are described and data for the evaluation of the properties of materials under varying conditions of temperature, stress and time are discussed.

SOME PROVEN GAS TURBINE STEELS AND RELATED DEVELOPMENTS

By D. A. Oliver and G. T. Harris

The austenitic steels R20 and G18B are discussed and new long-time creep data are presented for times up to 30,000 hours. The ferritic steels are reviewed and evidence is adduced to demonstrate the creep-strength superiority of the stainless H46 type up to 630 deg. Cent. The influence of gas atmosphere on oxidation and scaling of different steels is summarised and the comparative immunity of the cobalt-rich G32 steel to attack by fuel ash containing vanadium pentoxide is shown. Low and high-temperature properties of some widely used steels are recorded.

EFFECT OF WARM-WORKING ON AN AUSTENITIC STEEL (G18B)

By G. T. Harris and W. H. Bailey

Warm-working (at 700 deg. Cent.) improves room-temperature tensile properties and creep strength and permits the use of higher bore stresses in turbine discs. The effect of disc size is discussed. Future developments of the warm-working process, apart from the gas turbine field, are visualised.

DEVELOPMENT OF A HIGH-TEMPERATURE ALLOY FOR GAS TURBINE ROTOR BLADES

By G. T. Harris and H. C. Child

The general effect of carbide forming elements on the creep strength at 750–800 deg. Cent. of austenitic Ni-Co-Fe-Cr alloys has been investigated. Optimum creep strength occurred when at least three carbide-forming elements were present in percentages carefully balanced with carbon content, and when the alloy was rich in cobalt. On this basis G32, a cobalt-rich alloy, was developed. The nature of the phases which precipitation-harden some of the alloys has been investigated.

PROPERTIES OF MATERIALS INTENDED FOR GAS TURBINES

By H. W. Kirkby and C. Sykes

Room-temperature tests and creep-resisting properties of ferritic and austenitic steels for gas turbine and jet engines are recorded. The data also provide information on the variation of properties with size. Attention is directed to the properties of an "austerity" austenitic steel (R. ex 467) containing neither cobalt nor niobium.

STUDY OF THE PROPERTIES OF A CHROMIUM-NICKEL-NIOBIUM AUSTENITIC STEEL

By H. W. Kirkby and C. Sykes

The paper deals with the properties of 18 : 10 chromium-nickel steel stabilised with niobium. Creep properties up to 20,000 hours at 550–700 deg. Cent., the effect of heat-treatment and of grain size, room-temperature properties as affected by exposure at 600–650 deg. Cent., and fatigue properties are recorded, and factors which may influence the shape of the creep curves obtained are discussed.

CREEP-RESISTING FERRITIC STEELS

By E. W. Colbeck and J. R. Rait

Detailed properties of the 3 per cent Cr-Mo-W-V steel in the wrought condition are provided, including a few long-time creep tests, and some preliminary tests of the creep properties in the cast condition. As a result of a systematic investigation, in which the chromium was varied from 0 to 12 per cent, it is believed that at least three other steels, with 0, 1 and 10 per cent of chromium and excellent creep properties, will become available in the near future.

FERRITIC STEELS FOR GAS TURBINES

By H. H. Burton, J. E. Russell and D. V. Walker

Test results on three ferritic creep-resisting steels, mainly of the 3 per cent Cr-Mo-W-V type, are presented, the test specimens being taken from forged discs as well as from bars. The effect of variations in treatment and mechanical properties on the creep properties has been investigated and data on the effective modulus of elasticity at test temperatures are given. The results are compared in the light of requirements for materials for turbine discs in aircraft gas turbines.

SPECIAL STEELS FOR GAS TURBINES

By W. E. Bardgett and G. R. Bolsover.

Data are given of tests on a complex alloy to indicate the effect of individual elements and of the amount and direction of forging, on a 25 : 15 chromium-nickel type steel, suitable for combustion chambers, and on a steel containing chromium 20, nickel 30 and titanium 1 per cent, also suitable for combustion chambers, which showed good creep properties at 650 deg. Cent. in the form of a disc.

Dr. H. Sutton (Ministry of Supply) acted as rapporteur for this group of papers. After referring to the more important features of each contribution, he said that the papers gave a good general picture of the work leading to the adoption of materials used in British engines for the more critically stressed components, in particular for moving blades and discs. The progress of the ferritic discs had been an achievement of special consequence to the economic and strategic sides of the subject.

Sir William Griffiths (formerly Mond Nickel Company), in opening the discussion, referred to the early development of Nimonic 75, which had never, in fact, been used for blades, because by the time it had been developed requirements had changed and nickel-chromium-titanium alloys of the Nimonic 80 type became available. Difficulties were involved in meeting the requirements of a rapidly developing subject and, before the prolonged creep tests asked for by users were completed, it might often happen that some more promising alloy was already available for test. The discussion might, therefore, most profitably be devoted to the broad principles of the problem of developing high temperature alloys. It seemed clear that precipitation-hardening was going to be an important factor, either in simple alloys with one precipitant or in more complex alloys in which a large number of possible precipitants had to be balanced against one another. His own

feeling was that efforts in the near future must necessarily be in the direction of simplification. The factor of large-scale production should always be kept in mind. There was scope for discussion on the relative merits of production methods, and on such a phenomenon as negative creep. Although he had considered that such dimensional changes should be avoided as indications of instability, which might have harmful effects, it would be worth considering whether some profitable use might not be made of them.

Dr. W. Siegfried (Sulzer Bros., Ltd., Switzerland) said that creep tests on cylindrical specimens were insufficient. There were, in certain circumstances, multi-dimensional stresses, notch effects and, in some components, cold deformation. In connection with blade root design he also carried out room-temperature tests, photo-elastic tests, and sustained load tests at service temperatures on blade root models as well as tests on notched test pieces with different forms of notch. Tests on form of notch in relation to blade root connections showed noteworthy results. Notch-sensitivity changed with temperature and also with duration of test. Different steels reacted differently to cold deformation.

Mr. R. W. Powell (National Physical Laboratory) discussed thermal conductivity in relation to electrical conductivity. Thermal and electrical conductivities of some fifty steels and other alloys for high-temperature use had been measured. Two relationships were found; one for gamma-iron steels and Nimonic alloys and the other for steels containing alpha-iron, the 13 per cent chromium steels showing an anomaly at the lower temperatures. Thermal conductivity of many of these materials could be predicted from the much simpler measurement of the electrical resistivity.

Mr. J. Mowat (William Beardmore and Co., Ltd.) referred to work at Parkhead on 3 per cent Cr-Mo-W-V steels, which tended to show that the essential feature of this steel for high creep strength was its high vanadium content, and that the tungsten could be omitted for many applications. Molybdenum-vanadium steels, which had good creep resistance up to 550 deg. Cent. at least, were improved by the addition of 1 per cent chromium in conjunction with not more than 0·2 per cent of carbon. In fairly large forgings of this steel, uniformly good properties, similar to those obtainable from the more expensive 3 per cent Cr-Mo-W-V steel, were achieved by water quenching in a special apparatus, in which the forging was rotated while under high pressure water jets.

Mr. W. Betteridge (Mond Nickel Company, Birmingham) said that in any scientific approach to the problem of materials resistant to creep, the fundamental mechanism operating must be considered. Creep could occur by two principal processes: slip within the grains and viscous flow of the grain boundaries. The softer the grains at the test temperature the greater the component of strain due to grain flow; so that in over-aged or softened material grain flow would form the major part of the observed strain and grain-boundary flow only a small part, and the observed creep would not be very dependent on grain size. This was in line with the conclusion of Kirkby and Sykes that grain size *per se* only played a secondary role in controlling the creep properties and that the major factor was the condition of the hardening precipitate. It would appear that a coarse grain size was advantageous only when the grains themselves were so rigid that the creep rate was largely controlled by the rate of flow of the grain boundaries. Caution was, therefore, necessary in interpreting the effect, or lack of effect, of changes in grain size.

Mr. J. Glen (Colvilles, Ltd.,) referred to lack of information about long-time service, i.e., a life of 100,000 hours. He believed that it was possible to indicate the best type of ferritic steel for high-temperature service without using a creep machine. He illustrated how this could be done by carefully controlled tensile tests on normalised steels and on specimens which had been subjected to long-time tempering treatments. He described the development of a molybdenum-vanadium-titanium steel, which, although not scale resistant, could be protected by a chromising treatment and had surprisingly good creep properties.

Mr. A. Graham (National Gas Turbine Establishment) dealt with a formula intended to express the relationship between stress, plastic strain, straining rate and temperature. With a total testing time of sixty-five hours, he claimed to get not unreasonable predictions for times of 1000 to 10,000 hours.

Mr. H. J. Goldschmidt (B.S.A. Group Research Centre) wished to supplement information given in some of the papers by remarks on the use made of X-ray analysis in the investigation of heat-resisting steels. The lattice dimensions of the austenite matrix of G18B type steels were very sensitive to heat-treatment, and indirectly disclosed the precipitation of compounds even before their patterns became visible. Marked reduction of crystal size through ageing and warm working, and a pronounced preferred orientation after certain types of war work, could be recognised. The examination of electrolytic residues formed the main part of the X-ray programme and detailed results were given by Mr. Goldschmidt in amplification of the information contained in the paper by Messrs. Harris and Child.

Dr. K. W. Andrews (The United Steel Companies, Ltd.) stated that, from his own experience, he confirmed the observations of Kirkby and Sykes on the constitution of 18 : 10 chromium-nickel steel containing niobium. In spite of the presence of niobium, the carbide based on $Cr_{23}C_6$ precipitated readily towards lower temperatures in the range between 800 and 650 deg. Cent., and this carbide changed into the sigma phase after a certain time of heating. The same thing happened under these conditions in similar steels containing titanium.

Mr. G. T. Harrison (Armstrong Siddeley, Ltd.) speaking as a user, said he welcomed the stress now placed on economy and on machinability as well as on the actual high-temperature properties and in this respect ferritic steels like R.ex 448 and the revised 486 represented a real achievement. These steels could be used up to 650 deg. Cent. for parts which until recently would have had to be made in austenitic steels. He also drew attention to the importance of the development of the high-strength austenitic steel, R.ex 467, which did not rely for its properties on the presence of the more expensive alloy elements. Of the older alloys the pride of place must go to the Nimonic series. Since their inception they had dominated and continued to dominate, the British aero gas-turbines. Though other materials might be better at 800 deg. Cent., the properties of the Nimonic class at 650 or 750 deg. Cent. were very difficult to beat. High stresses occurred at the root of the blade and it was only when the creep properties of the material at the lower temperatures were reasonably high that failure in the cooler and more highly stressed parts of the blade could be guarded against. The properties of Nimonic alloys in the lower temperature ranges were of equal importance to their properties at about 800 deg. Cent.

Mr. Harrison gave examples of failures, one due to overstressing at temperatures below the maximum and another due to overheating. The properties of the Nimonic alloys fell catastrophically when the temperature reached that of the boundary of the single phase region (about 860–880 deg. Cent.) and now that aeroplane engines were running at temperatures round about 850 deg. Cent., either the limiting temperatures must be increased or greater attention must be given to the development of controls and similar devices to make sure that overheating of the turbines was absolutely impossible. During the early development of propeller turbine engines at his works, occasional failures from fatigue were experienced in turbine blades. It was now known that they were due to resonance and had nothing to do with the material. It had been thought that slight damage, or cracks due to local overheating, might initiate fatigue failure; but extensive tests had convinced him that Nimonic 80A had the capacity of standing up to the type of abuse liable to be experienced in the aero gas turbines.

(*To be continued*)

Portuguese Liner "India"

PORTUGAL has recently added another up-to-date unit to the merchant fleet, which serves its Colonies. The new vessel is the twin-screw passenger and cargo liner "India," which has been built at the yard of Bartram and Sons, Ltd., Sunderland, and completed successful sea trials last month. The "India" is now on her maiden voyage in the service of the owners, the Companhia Nacional de Navegcao, and will carry passengers and freight from Lisbon to Macoa, in the East Indies, by way of the West and East Coasts of Africa when outward bound and returning through the Suez Canal and the Mediterranean.

The accompanying photograph, taken during the trials, shows that the vessel has a pleasing profile, a raked contour plate stem, a cruiser stern, two masts, a streamlined funnel and a built-up bow-fronted 'midship deckhouse.

The vessel which is of closed shelter deck design, has two steel decks and an additional 'tween deck in way of the forward holds. Following modern practice, the hull is mostly welded, the only riveting being at the shell frames and for the major proportion of the shell seams. A point of interest is that troughed plate steel construction is used for many of the watertight bulkheads, of which there are eight, extending to the upper deck to provide the necessary watertight subdivision. The four holds are arranged two forward and two aft of the machinery space and No. 1 hold is covered by an extended forecastle. No. 2 lower 'tween deck is arranged to carry refrigerated cargo and part of the space is occupied by the ship's provision chambers. McGregor steel hatch covers are fitted and the cargo is handled by the normal derrick arrangements, including a 25-ton derrick at No. 2 hold, all of which are operated by electric winches made by Stothert and Pitt Ltd. These makers supplied the mooring capstan aft and

the windlass, while Donkin and Co. provided the "telemotor" controlled four-ram electro-hydraulic steering gear and the power-operated watertight doors. Fire prevention is taken care of by the fitting of smoke detection apparatus, by W. Kidde and Co., in all holds and 'tween decks, while the extinguishing arrangements consist of a sprinkler system installed by Mather and Platt, Ltd. Dreadnought fireproof doors are provided at certain points to localise and help to prevent a fire from spreading.

Passenger and Crew Accommodation

The first-class passengers are accommodated in single and two-berth cabins situated on the boat, promenade and upper decks, the single-berth cabins having an additional folding bed so that extra passengers can be carried. Many of the cabins have private bathrooms and all are excellently fitted out with built-in furniture, each cabin displaying different veneers which are incorporated in the panelling. To port and starboard of the lounge on the boat deck are self-contained two-berth *de luxe* suites, each having an entrance lobby, sitting room, bedroom and bathroom. Okumi wood is used for the panelling of one suite and figured ash in the other.

General Particulars

Length overall	430ft
Length between perpendiculars	404ft
Breadth moulded	58ft 9½in
Depth moulded to upper deck	37ft
Draught	25ft 8in
Deadweight (about)	6700 tons
Service speed	14½ knots
Service power	5000 b.h.p.
R.p.m.	136
Passengers :	
First class	60
Third class	16
White emigrants, or "Simla" pilgrims	284 / 488
Crew	93

The public rooms are placed above the other at the forward end of the 'midship deck house, and access to these and the cabins is by means of a central staircase which leads from the main entrance hall on the upper deck to halls on each deck. The spacious first-class dining saloon, at upper deck level, has seating accommodation for seventy and is panelled in blue washable hide with a dado of weathered sycamore. On the deck over is a well-proportioned smoking room and bar, in which the decoration is of straight-grained oak and oak burr with pilasters of walnut; openings to port and starboard lead to small verandah cafés in the wings. These cafés are provided with cane furniture, lined with green "linette Formica" and have direct access to the promenade deck. The lounge, which we show in our illustration, is on the boat deck; it is large enough to seat forty-five passengers and has an oak parquet floor, sprung in rubber for dancing.

M.V. India During Trials

White ash and ash burr veneers are used for the wall panels. The decoration and furnishing of the public rooms and cabins has been carried out by Hampton and Sons, Ltd. The aft end of the promenade deck has been kept clear and No. 3 hatch has wood-sheathed covers flush with the deck so that the space can be used for games. A portable swimming pool is provided and mounted on No. 4 upper deck hatch.

At the aft end of the house on the upper deck is the third-class accommodation, which consists of four four-berth cabins, together with a small dining room and a lounge. The white emigrants or unberthed passengers are carried in No. 1 lower and No. 1 and No. 2 upper 'tween decks, these spaces being specially arranged for the dual purpose of carrying passengers or cargo. Cooking and washing arrangements are provided within the long forecastle, which extends over No. 1 hatch.

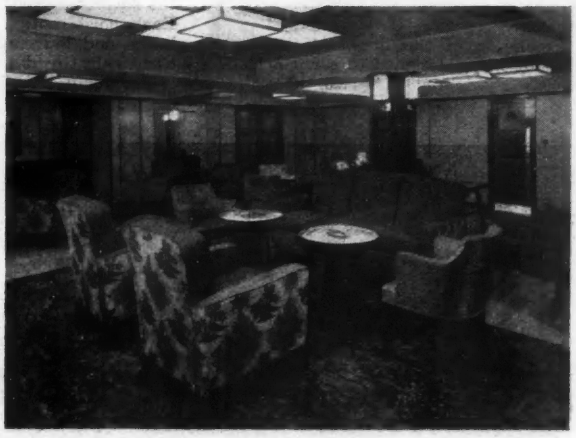
Above the boat deck is the officers' deck, on which are situated comfortable quarters for the deck officers. The captain has a suite arranged across the front of the house. The engineers have their cabins abaft the engine casing on the upper deck, the chief engineer having a suite of rooms. The assistant engineers, engine-room staff, stewards and seamen have their cabins, separate mess rooms and recreation space arranged in No. 3 and No. 4 'tween deck spaces.

A well-equipped galley and bakery are placed on the upper 'tween deck forward of the engine-room, and there is an electrically equipped laundry adjacent to the steering gear compartment. The service for which the ship is intended called for special consideration for ventilation and heating, and mechanical ventilation is fitted throughout the accommodation, including those spaces allocated to white emigrants.

Propelling Machinery

The ship is propelled by two Doxford two-cycle, direct-reversing, opposed-piston oil engine, built by the North-Eastern Marine Engineering Company (1938), Ltd. Each unit has four cylinders of 560mm diameter by 1680mm combined stroke, is rated to develop in service 2500 b.h.p. at 136 r.p.m., and drives a three-bladed manganese-bronze propeller of 13ft 2in diameter and a mean pitch of 12ft 4½in. The arrangement of the well-planned engine-room follows normal lines with the exception of the shaft recess, which is considerably larger than usual and has dimensions sufficient to allow a main generator to be mounted between the shafts.

Air for the main engines is stored in three air vessels placed against the forward bulkhead and supplied by three air compressors fitted forward and to starboard. Two of them are vertical, two-crank, three-stage compressors, by Peter Brotherhood, Ltd., each delivering 150 cubic feet per minute and the third, an auxiliary vertical-crank, two-stage Weir compressor with a capacity of 20 cubic feet per minute. Scavenge air is supplied by a central crank-shaft operated pump. The main pumps, supplied by Drysdale and Co., and coolers are arranged, fore and aft, to port and starboard of the engine-room. Two jacket water pumps and coolers are forward to port and two lubricating oil coolers and strainer are placed forward of the port engine.



First Class Lounge

On a flat at the forward end of the engine-room is a Cochran vertical multitubular boiler, 5ft 6in in diameter and 14ft 9in high, which is arranged for firing by oil fuel or exhaust gases from the port engine. In common with most passenger ships trading to the Far East, the problem of an ample supply of fresh water is met by fitting a high-pressure distiller, capable of producing 2000 gallons per day.

Electricity is used throughout the ship for auxiliary purposes and, to supply sufficient power, four 200kW, 220V d.c. Allen generators are fitted, each being driven by a Mirrlees four-cycle, single-acting, airless-injection diesel engine. Two generators are mounted to starboard and one to port of the engine-room, while the fourth, as already mentioned, is sited between the shafts in the tunnel recess. On the upper deck to port and abreast the engine casing there is fitted a 50kW Clarke Chapman generator, driven by a Crossley five-cylinder, 85 h.p. diesel engine.

A sister ship, the "Timor," is nearing completion and both vessels have been built under the special survey of Lloyd's Register of Shipping and comply with the latest requirements of the International Convention for the Safety of Life at Sea, the Ministry of Transport requirements and the "Simla" rules for unberthed passengers.

Cement Company's Jubilee Brochure.—To commemorate its fiftieth anniversary, the Associated Portland Cement Manufacturers, Ltd., which is the parent company of the Blue Circle Group, has prepared an illustrated brochure describing the history and development of the company and the work which it undertakes. The brochure may be obtained from the Cement Marketing Company, Portland House, Tothill Street, London, S.W.1.

A 350-Ton Overhead Travelling Crane

An overhead travelling crane with a lifting capacity of 350 tons, designed and built by the Wellman Smith Owen Engineering Corporation, Ltd., of London and Darlaston, was recently installed in a new assembly and test house at the works of the English Electric Company, Ltd., at Stafford. The general layout and dimensions of the crane can be seen in the drawing on this page and some of its details appear in the photographs we reproduce.

The crane is of the double trolley type, each trolley being designed to carry a load of 175 tons. By linking the two lifting units with a cross beam a total load of 350 tons can be handled, or, if desired, an overload of up to 400 tons. In addition to the main hoist each of the trolleys carries an auxiliary hoist of 5 tons capacity for handling light loads, such as the heavy slings used for lifting loads on the main hooks.

The crane runs on gantries having centres spaced 77ft 9½in apart and each gantry carries two rails set at 15in centres. The height from floor to rail level is 50ft. The main hoists are equipped with 90 h.p., 700 r.p.m. motors, which give a hoisting speed of 5ft per minute. The auxiliary hoists have 30 h.p. motors, giving a speed of lift of 60ft per minute. Each trolley is equipped with a 30 h.p. cross traverse motor, giving a movement speed of 55ft per minute. A 120 h.p. motor running at 600 r.p.m., which is provided for the long travel motion of the crane, gives speeds along the length of the shop from 165ft down to 115ft per minute, depending on the weight of load carried. The total weight of the crane with cross beam is 250 tons.

Two cast iron barrels on each of the main hoisting gears and one on each of the auxiliary hoisting gears are driven by their motors through suitable reductions of machine-cut spur gearing. The barrels on each hoist are grooved right- and/or left-hand and are of sufficient diameter and length to wind the whole of the rope for the full range of lift in a single layer without overlapping. The rope ends are anchored to the barrels and three extra coils of rope left on the barrel when the hook is in the lowest position, provide additional security. Each hoist motion is fitted with a magnetic brake and lowering of the load is controlled electrically by dynamic braking.

The main hoist, auxiliary hoist and cross traverse first and second motion reduction gears are enclosed in welded steel oil bath gearcases, the bearing housings being formed integral with the cases. Other gears and exposed rotating parts have sheet steel guards where necessary. The large diameter, machined and suitably grooved cast iron rope sheaves are bushed with gun metal and the pulley pins have grease gun lubrication.

The traverse cross shaft and barrel shaft bearings, made of cast iron, are gun metal bushed. These units are all fitted with adjustable caps and provided with nipples for grease gun lubrication. The motor extension shaft is fitted with roller bearings. All shafts and axles are of rolled steel of ample proportions to withstand the combined torsional and bending stresses to which they are subjected. Wellman-Bibby all-metal flexible couplings are fitted between all the motors and motor extension shafts.

The snatch blocks have gun metal bushed cast iron pulleys, which are suitably guarded to protect them from injury and to prevent the ropes from leaving the grooves. Each of the Ramshorn hooks of forged steel is carried by a double-row ball thrust bearing. Each trolley is mounted on four twin double-flanged gun metal bushed cast steel runner wheels running on axles fixed in the trolley frame. Two opposite twin runners, one on each side of the frame, are fitted with spur rings, which mesh with pinions keyed to the extremities of a cross shaft, driven from the motor through spur reduction gearing.

The trolley frames are of riveted construction and in them the rolled steel sections are arranged in as simple a manner as possible, to afford ready access to the gearing for cleaning and repair purposes.

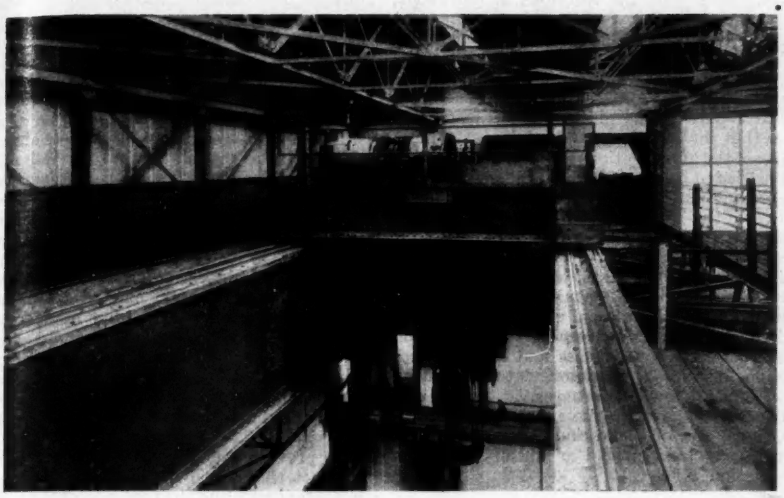
The crane runs on twenty-four wheels, of which six are mounted in each half-end carriage. Four wheels in each half-end carriage are carried in a separate bogie frame pivoted to the carriage structure. As each gantry is supplied with twin rails, the carriage wheels are arranged in pairs, each pair running on the same axle. These twin wheels are of composite construction, having rolled steel tyres shrunk on to cast iron centres, and they are double-flanged. The treads are machined to ensure uniform diameter and the gun metal bushed wheels run on centrally lubricated fixed axles. The two independent end-carriages at each side of the span are articulated and connected by double link plates and pivot pins.

Four twin wheels in two opposite end-carriages supporting the same set of girders, are fitted with spur rings and are driven from a cross shaft. This cross shaft is carried in bearings, pitched at close intervals along the girders. It is driven through a reduction of enclosed spur gearing by a motor mounted at approximately the centre of the span to ensure the drive being transmitted simultaneously to both end-carriages. This driving unit is equipped with an electro-hydraulic brake.

The crane girders are constructed in two separate units, each of which consists of a main girder of double web plate riveted construction with a lattice braced outrigger

350-Ton Overhead Travelling Crane

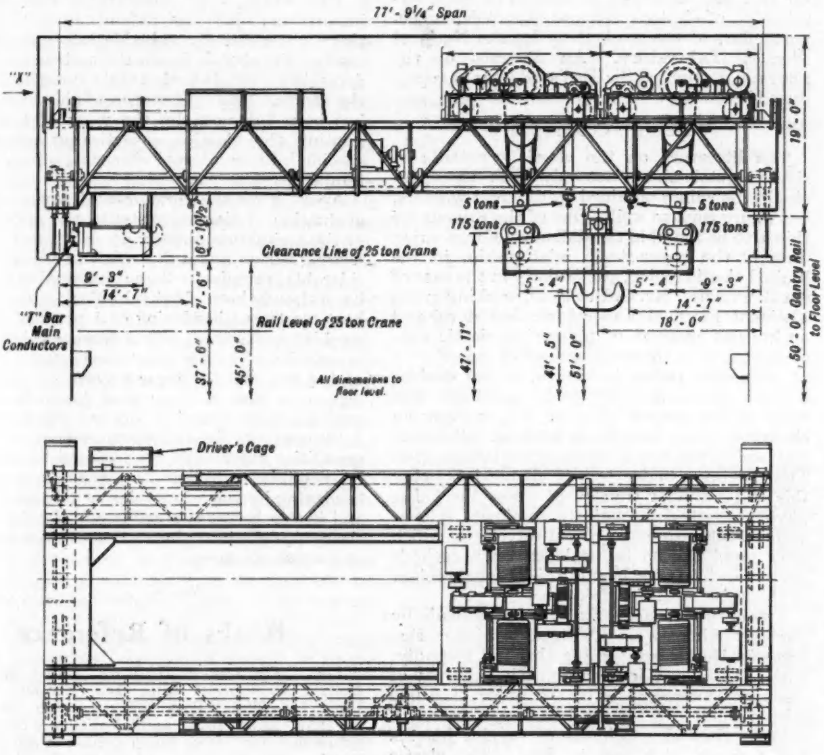
girder. The girders of each unit are braced together in both horizontal and vertical planes to give adequate lateral rigidity and are mounted on box section end-carriages. The two units are linked together to form a compensated whole. On the top flange of each main girder and spaced 7ft 9in from the crane



TRANSVERSE VIEW OF CRANE

centre line are attached twin rails on which the two trolleys run. Timber platforms on the top level of the girders give access to the trolleys, and platforms along the bottom level of one girder unit give access to the long travel gear.

An open driver's cabin underslung from one



GENERAL ARRANGEMENT OF CRANE

end of the girders gives the driver an unobstructed view of the load in any position. Access to the compartment carrying the electrical control equipment is gained from the driver's cabin by means of a steel rung ladder.

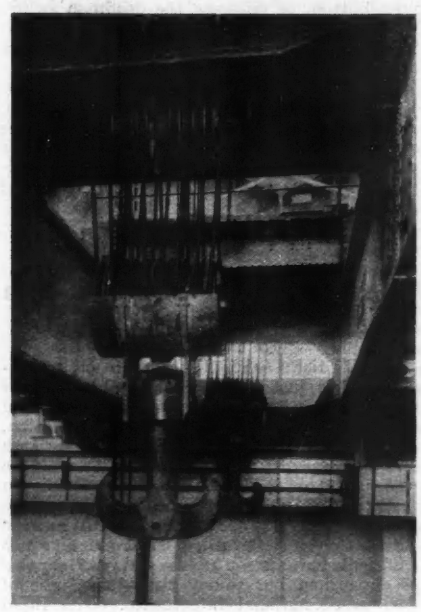
The overall dimensions of a main girder with its auxiliary girder are 81ft long by 7ft 6½in deep by 8ft 3in wide, the combined weight being approximately 50 tons.

Electrical Equipment

All the motors for the crane were supplied by the English Electric Company, Ltd., and are totally enclosed, series wound, half-hour rated crane motors designed for use on a 500V d.c. supply.

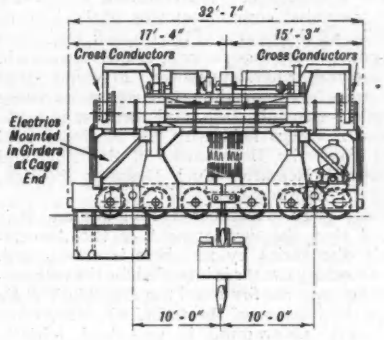
All motions are controlled by Allen West enclosed contactor panels with unbreakable grid resistances and are operated by master drum controllers. The panels are housed in compartments inside the crane girders and the resistances are mounted on the platforms above.

All the hoists are arranged for series hoisting with potentiometer and dynamic braking control on the lowering side, whilst the travel and both traverse motions are arranged for plain series control in each direction. All



MAIN GIRDERS AND SNATCH BLOCKS

controllers are fitted with crank handles, the travel handle incorporating a deadman switch. The main (90 h.p.) hoists and the traverse controllers have handles specially arranged to



VIEW ON ARROW "X"

enable them to be used independently or for simultaneous operation when handling the maximum load.

Each hoist is fitted with a self-resetting limit switch to prevent over-hoisting. These switches are driven direct from their respective hoist rope barrels and are connected in the control circuit of the main circuit breaker, which opens when the limit has been reached.

Each of the four hoists is fitted with a series wound direct-acting short-stroke Igranic magnetic brake, whilst the travel motion is fitted with a similar brake but of the hydraulic electric pattern, having a continuously rated shunt coil. This brake is mounted on the motor extension shaft and is connected so that it remains "off" during normal use of the crane but can be applied at will by the driver, through a pedal operating a hydraulic master cylinder. The brake is automatically applied on current failure, by pressing the emergency stop push-button or by opening the main isolating switch.

A crane protective panel in the contactor compartment in the girders consists of a main double-pole contactor type circuit breaker and self-resetting overload relays, one for

each motor and one common relay on the negative main. These units are designed to open the circuit breaker in the event of overload occurring on any motor, the breaker also opening on failure of voltage, tripping of a limit switch, pressing the emergency stop push-button, or releasing the deadman switch whilst the travel motion is being operated. The breaker recloses only when all controllers are brought to the off position.

A 500A double-pole, ironclad switch is provided to isolate the crane completely from the main downshop conductors. Switch-fuses are also provided for the lighting in the driver's cab, for the lighting in the contactor compartments in the girder, and for sockets to feed inspection lamps.

The British Coal Utilisation Research Association

THE British Coal Utilisation Research Association has just issued its annual report for 1949, which is its first report since the beginning of the last war. The purpose of the Association, as restated in the report, is to promote research and other scientific work in connection with the utilisation of coal and its derivatives. In furthering this aim, three main objectives are pursued, and these are enumerated. When the Association was formed, coal production was sufficient for current needs and was capable of expansion, but to-day the efficient use of coal is of national importance. The rapid increase in staff of the Association raised accommodation difficulties which were solved by the acquisition of a site at Leatherhead upon which to erect permanent buildings. The "Combustion" building was occupied in 1945 and the construction of a "General Purpose" building was approved in 1949.

The committee structure, it is revealed, was amended in 1948 and caused the merging of earlier committees. With certain exceptions the executive committee was authorised to exercise all the powers of the Council, and three sub-committees were formed, namely, research, finance and general purposes. Five industrial categories are named in the report as being eligible for membership, and mention is made of the meetings held with the National Coal Board and the Department of Scientific and Industrial Research Fuel Research Station, to co-ordinate research.

The service to members is reviewed and it is stated that the development of the Association's discoveries by members is encouraged. The *Quarterly Gazette* is intended for the managements of member firms and the *Monthly Bulletin* is for the interest of the technical staffs, while the work programme is presented initially through the information circulars. The total staff is given as 265, including seventy qualified scientists and engineers. There are five divisions, namely, Technical Research (Domestic), Technical Research (Industrial), Laboratory Research, Technical Services and Central Administration.

The research report is given in three parts and the published papers and reports related to each section are listed. The main objective of previous years, recent developments and the 1949 programme of the Technical Research (Domestic) Division are reviewed and special reference made to the radiometer in the section dealing with development of research instruments.

The report on the Technical Research (Industrial) Division is in three sections, namely, boiler, furnace, and gas producer departments. The two main objectives of the boiler department during 1949 are given and the report mentions the installation of a boiler for the study of coal characteristics, the first tests being with low-ash coal. With reference to the furnace department the Downjet furnace developments are recorded, as are the conclusions with regard to the burning of coal fines and the progress of work concerning the solid fuel firing of gas turbines. The main aims of the gas producer department are listed and notes given with regard to various operational investigations and field trials, such as the effect of operating with an increased exit pressure and the effect of fuel bed depth on gas quality.

The Laboratory Research Division report is divided into three sections, covering the work of the combustion, physics, and chemistry departments. The combustion department, it is stated, is concerned with the reactions in fuel beds, reactivity of solid fuels, and the internal burning of fuel particles. Boiler availability is being studied with special reference to the sulphur content of the fuel and corrosion of air heater elements.

The report of the physics department indicates that the study of fine particles is the main theme of the investigations which cover sampling of dust-laden gases, grindability of coal, particle assessment and granular materials. Earlier work of the chemistry department included studies of the colloidal properties of coal, and it is reported that the properties and uses of coal/amine mixes are being studied and processes devised for deriving certain products. The chemical properties of coal are being examined and there is a note concerning the conversion of tar distillate constituents and also the production of zircon refractories to withstand conditions in Downjet furnaces.

The report includes the names of Members of Council and of the various committees, and there is a classified list of members of the Association.

Ultrasonics in the Determination of Elastic Constants of Metals

SCIENTIFIC problems in the Department of Scientific and Industrial Research (D.S.I.R.) formed the subject of an address given by Sir Ben Lockspeiser, K.C.B., F.R.S.,* to the Scottish branch of the Institute of Physics on February 13th. One of the topics discussed by Sir Ben was the use of ultrasonics in the determination of elastic constants of metals and, in particular, of the work done by the National Physical Laboratory. An abstract of the relevant portion of Sir Ben's address is reproduced herewith.

ELASTIC CONSTANTS

The literature on the elastic constants of single crystals shows not only large discrepancies in the values obtained by different workers, but many gaps as well. One of the reasons for this is to be found in the difficulty of measuring directly the stress-strain relationship, in the limited elastic region, particularly in the case of small crystals. Mr. G. Bradfield, working in the National Physical Laboratory, has developed an indirect method of measuring elastic constants based on the measurement of the velocity of ultrasonic pulses in metals, which enables a much greater accuracy to be obtained. The basis of the method consists in converting an electrical pulse waveform into an ultrasonic mechanical pulse by a quartz crystal transducer. The specimen under test is clamped between this and a similar transducer where the pulse, having travelled through the specimen, is converted back into an electrical waveform, which after amplification is displayed on a cathode ray tube. The time base of this is synchronised to the pulse repetition frequency.

Travel time measurements are then made by photographing the trace with calibration marks, first with the transducers together and, secondly, with the specimen in position. The accuracy of these measurements is of the order of 0·005 microseconds and the total scatter of values of velocity through specimens of varying lengths has a range of 1 part in 3000. The elastic constants can then be computed from velocities of longitudinal or transverse waves, according to the type of transducer used, and transmitted along known crystallographic axes provided the density is known.

ELASTIC MODULI

The resonant frequencies of induced oscillations in a body are directly related to the elastic moduli, and the accurate measurement of resonant frequencies provides a convenient method, capable of high accuracy, in the measurement of elastic moduli. Vibrations, longitudinal or torsional, of continuously variable frequency, are excited in specimens preferably cylindrical in shape. A convenient method of excitation makes use of the magnetostrictive effect of nickel. Two thin nickel rods are placed in contact with the ends of the specimen; one is surrounded by a coil connected to a variable frequency oscillator and excites vibrations in the specimen, the other is surrounded by a coil connected to an amplifier which is used to indicate resonances set up.

The elastic moduli of the material may be computed from the resonant frequencies and from the density, bearing in mind the necessity to apply a correction to the lateral expansion of specimens in the form of rods, and of the deviation, in general, from the true harmonic law of the higher order modes. Torsional vibrations can also be excited by a method similar to this and the rigidity moduli may be computed from the torsional resonant modes.

Ultrasonics has proved to be a very useful tool for increasing the accuracy of the measurement of the elastic properties of metals especially when the dimensions of the available material are small. The pulse and resonant methods each provide a good check on the other, and the fact that two basic methods exist has an important effect on the precision of the measurements. In view of the small size of specimen required, the ultrasonic methods can be successfully applied to materials not easily obtainable in large quantities. This is a valuable asset in connection with measurements to be made on polycrystalline aggregates of alloys which include the rarer metals. Work on these alloys is now in progress, and although the results have yet to be analysed in detail it is clear that very much less than 1 per cent of an alloying element can give rise to large changes in the elastic constants.

This work is of considerable fundamental importance, since the magnitude of the elasticity gives directly valuable information concerning the atomic forces themselves and their dependence on the electronic constitution of the atoms. The importance of this knowledge has been enhanced by the work of Debye in relating the elastic properties of matter to specific heat or internal energy as a function of temperature.

Apart from the fundamental aspect of the evaluation of elastic constants, the application of the techniques already described as an engineering test of a non-destructive type is of considerable promise. Some interesting results have already been obtained. For instance, the heat-treatment hardening of 1 per cent carbon steel is accompanied by a change of 1·1 per cent in velocity of longitudinal waves and a change of 1·8 per cent for shear waves. Cold-worked copper is also 0·7 per cent lower in elastic modulus than annealed copper. Since steps of 1/10 per cent in the measurement of these quantities can readily be distinguished, it may be possible to follow the various stages in hardening by some extension of these methods, and if this becomes possible one should gain a clearer insight into physical processes which are at present obscure.

* Secretary of the Department of Scientific and Industrial Research.

Books of Reference

Post Office London Directory, 1951. London: Kelly's Directories, Ltd., 186, Strand, W.C.2. Price £5.—The "Post Office London Directory for 1951" is the 152nd annual edition of a valuable reference book. It contains a mass of information relating to the streets, residents, industrial establishments, transport, banking, and commerce of the London postal area, all of which has been arranged in a very convenient and orderly manner. There have been vast changes in the Metropolis since the Directory first appeared in 1799, but the aim of the publishers has always been to include the most up-to-date information in every new edition. In the twelve sections of the 1951 edition, that object has again been successfully achieved. The sectional street plan accompanying the volume is particularly useful.

Radio-Controlled Ship Models*

By S. G. LANKESTER and S. G. DREIER†

For steering investigations at the Admiralty Experiment Works, Haslar, electrically propelled wooden models up to 26ft long are run in Horsea Lake and so far have been controlled either by human helmsmen or by a special time clock. In the usual type of steering experiments the model starts out on a straight approach course for about 20 yards to 50 yards, carries out a complete circle and then stops (Fig. 1). The model's course is plotted by a special camera; motor speed, rudder torques and pressure, and heel, are recorded automatically, and the circles are repeated for different speeds of approach and rudder angles.

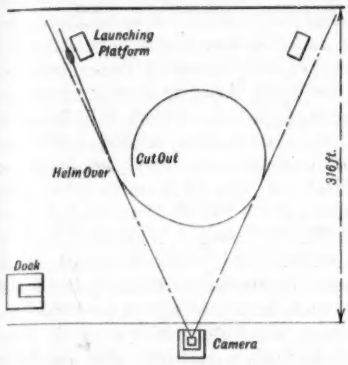


FIG. 1—STEERING COURSE AT HORSEA LAKE

The aim of the experiments is to forecast the steering performance of the full-scale ship and to assess the difference in the steering performance resulting from fitting different forms of rudder or from modifications to the afterbody of the ship.

Control of Models

A helmsman is undesirable because he is too heavy and is also inclined instinctively to shift his weight when the model goes into a turn, and so alter the angle of heel, which will in turn affect the turning circle. Larger models cannot be used, due to limitations imposed by the lake area.

Recent models have been controlled by a time clock, evolved at Admiralty Experiment Works, which gives the necessary rudder order after a predetermined time of approach run, and stops the main motors after the circle is turned. The setting of the time intervals on the clock, and the course on which the model is released, have to be very accurate; otherwise there is a risk of the model turning outside the field of view of the recording camera or colliding with the bank. Collecting the model by motor boat is a time-wasting factor, and much time would be saved and risk of damage to the model avoided with a satisfactory system of remote control. Work at Horsea Lake is dependent on weather conditions, so it is essential to carry out as many runs as possible on the really suitable days in the year.

The most important requirement for a system of remote control is that the rudder angle applied by a given order from the shore should be accurate to within $^1/_{10}$ deg. The control should also be able to cause the main motors to run slowly for the return run, and to stop them in an emergency. Its weight should be under 20 pounds.

Radio Dial Code System

One of the two radio control systems now under development at Admiralty Experiment Works uses a transmitter frequency within the band permitted by the G.P.O. for model control systems. By means of a telephone dial switch and control unit, signals of up to ten rapid impulses can be transmitted, preceded by a long pulse, at any single operation of the dial. The long pulse "saturates" the ship borne unit via a slugged relay until dialling is completed; this prevents incorrect interpretations being accepted. A tone-modulated carrier wave is used to reduce the chance of the model responding to interference.

The model carries a control unit with a receiver designed to operate a uniselector switch and a succession of relays. Dialling transmits a series of signals to the model which are "sorted" by the control unit, and relays operate the main motor switch and steering motor as required. The present weight of this system is unfortunately about 27 lb, excluding the weight of the 12V battery; in some models, however, it should be possible to obtain the 12V from a tapping off the batteries driving the propulsion motors.

A series of contacts at 5 deg. spacing is attached to the steering quadrant and connected to a uniselector (Fig. 2). On dialling, for example, the codes for "port rudder" and "25 deg." the steering motor is started in the port direction and one bank of the selector is connected to the 25 deg. contact. When a wiper arm on the rudder stock reaches the 25 deg. contact a relay trips and the steering motor current is interrupted. A magnetic brake, which is "held off" the whole time the steering motor is energised, prevents overrunning.

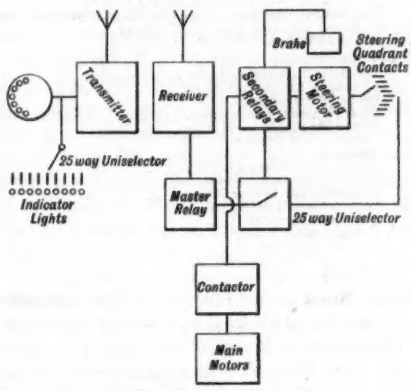


FIG. 2—DIAL CODE SYSTEM

The various codes available are tabulated below.

Codes Available in Shore Control Unit

Code	Evolution	Indicator light
2	Stop	Nil
3	Start	Blue
6	Slow	Opal
4	Port	Red
5	Starboard	Green
7	'Midships	Amber
81	5 deg.	White
82	10 deg.	"
83	15 deg.	"
84	20 deg.	"
85	25 deg.	"
86	30 deg.	"
87	35 deg.	"
88	40 deg.	"
89	45 deg.	"

So that the operator is always aware which codes are operative at any time, indicator lamps are fitted in the shore unit. In the ship borne unit the whole system automatically restores to normal after each evolution is completed. In order that the operator may know the latest "state" of the model, it is arranged that automatic homing takes place in the shore unit only after the first four codes, i.e., start, stop, starboard and port. After all subsequent codes the control unit remains in the energised state although the unit in the model, which is similar electrically, has restored. The operator can thus see the last intelligence transmitted to the model even though the model control unit is restored to normal.

The operator presses a manual clearing button before dialling any code subsequent to the fourth code, in order to restore the control unit to the no signal condition and avoid incorrect indicator lamps being illuminated.

As an example of a typical operation, to start a model, run with rudder amidships, carry out a 360 deg. turn to starboard with 15 deg. of rudder, and then proceed slowly to the opposite shore, the codes would be as follows:—

Evolution	Code
Start model	3
Rudder amidships	7
Starboard turn with 15 deg. rudder	Press clearing button, dial 5 then 83
Rudder amidships	Press clearing button, dial 7
Slow	Press clearing button, dial 6
Stop	2

Discriminator System

A possible disadvantage of the above system is the time taken to dial each required order. An alternative system now under development uses a transmitter with amplitude modulation at variable frequency from an audio beat-frequency oscillator. The receiver output is connected to a low-frequency discriminator, tuned to a normal mid-frequency of 500 c/s, and also two (or more) filters tuned to 4000 and 8000 c/s respectively. The discriminator operates a two-way moving coil relay which energises the steering motor to port or starboard, depending on whether it receives a "positive" or "negative" signal. One of the tuning condensers of the discriminator is connected to the tiller of the model so that in the "hard-a-starboard" position the mid-frequency becomes 600 c/s (and 400 c/s for a hard-a-port).

On raising the modulation frequency from 500 to, say, 550 cycles the discriminator output energises the steering relay in the starboard direction. When 22½ deg. of starboard rudder is reached the mid-point of the discriminator frequency becomes 550 c/s, the steering relay is de-energised and the steering motor stops. On transmitting signals with a modulation frequency of 4 and 8 kc/s, the model is slowed and stopped respectively, by means of relays connected to the two higher frequency filters.

The dial code system of radio control has already been tried in a wax model in the Haslar tank and, after small modifications, will soon be in use at Horsea.

* *Admiralty Bulletin.* Abstract.

† Admiralty Experiment Works.

Technical Reports

Current-Carrying Capacity of Bare Stranded Conductors. Second Report (Ref. O/T5). By E. E. Hutchings, B.Sc.(Eng.), A.M.I.E.E., and R. G. Parr, B.Sc.(Eng.). The British Electrical and Allied Industries Research Association. Price 9s. 3d., post free.—Provisional current ratings for conductors exposed to a 1 m.p.h. wind given in an earlier report (Ref. F/T142) were based on forced convection coefficients for smooth cylinders of larger diameters than those of normal overhead line conductors. The present report describes tests to determine such coefficients for the range of conductor types and sizes in general use, and the corresponding ratings are deduced for various conditions. The still air ratings given in Ref. F/T142 are also confirmed and extended to include additional conductors.

The A.C. Argon Arc Process for Welding Aluminium. The Oscillographic Analysis of the Application of a Commercial High Frequency Spark Injector Unit (Ref. Z/T80). By L. H. Orton, Ph.D., F.Inst.P., J. C. Needham, B.Sc., and J. H. Cole, M.Sc. The British Electrical and Allied Industries Research Association. Price 5s. 4d., post free.—This report is the first of a series on the oscillographic analysis of electrical phenomena in the a.c. argon arc process for welding aluminium. Characteristics of a typical high frequency spark injector unit are considered in relation to their importance to welding. The investigations are being conducted in the laboratories of the Electrical Research Association in collaboration with the British Welding Research Association, to which Mr. Cole belongs.

In this report results are given of applying electromagnetic and cathode ray oscillographic recording techniques to the study of certain electrical parameters in the a.c. argon arc process for welding aluminium. The output from a commercial high-frequency spark oscillator, such as is commonly used in practice, is here examined in relation to this particular application. The output from such a unit is not continuous but consists of a "grouped series" of sparks separated by dead periods, in which sparks are absent. It is shown, both experimentally and from consideration of the nature of the output that the success of the welding process depends, largely, on the requirement that the injected spark groups should be correctly phased relatively to the main welding current. This implies that correct phase adjustment should be made between the input supplies to the high frequency spark unit and the welding transformer.

THE ENGINEER

Vol. CXCI MARCH 9, 1951 No. 4963

Contents

PAGE

LEADING ARTICLES—
Defence of the Atlantic ... 320
Steels and Alloys for Gas Turbines ... 321
Design of Aircraft Runways ... 321

SPECIAL ARTICLES—
Activities of the Creusot Works of Messrs. Schneider. (Illus.) ... 311
High Temperature Steels and Alloys for Gas Turbines. No. I: Iron and Steel Institute ... 313
Manufacture of Deep Drawing Steel. No. I. (Illus.) 306
Mechanical Engineers in the Process Industries: Institution of Mechanical Engineers ... 324
Socialisation of Industry ... 309

British Coal Utilisation Research Association ... 318
Dollar Export Convention ... 328
Highway Surfacing Machine. (Illus.) ... 330
Improved Cleaning Press. (Illus.) ... 331
Mobile Air Compressor Unit. (Illus.) ... 330
Portable Fluorescent Hand Lamps. (Illus.) ... 330
Portuguese Liner "India." (Illus.) ... 314
Radio-Controlled Ship Models. (Illus.) ... 319
Shin Hydro-Electric Scheme. (Illus.) ... 326
Shortage of Electrical Power Capacity in West Germany ... 326
Six-Spindle Automatics. (Illus.) ... 331
Two-Drum Integral Furnace Marine Boilers. (Illus.) 327
Ultrasonics in the Determination of Elastic Constants of Metals ... 318
Workshop Projector. (Illus.) ... 330
350-Ton Overhead Travelling Crane. (Illus.) ... 316

PAGE

LETTERS TO THE EDITOR—
Determination of Critical Loads by Energy Methods (Illus.) ... 323
Engineering Institutions ... 323

LITERATURE—
Short Notices ... 323

OBITUARY—
A. H. Peppercorn ... 322
Edgar Alcock ... 322
Sir P. Malcolm Stewart ... 322
Sir James Pringle ... 322
A. J. Leyland ... 323

A SEVEN-DAY JOURNAL ... 305
Atomic Energy School
Chair of Electrical Engineering at Cambridge
Metropolitan Water Board's Annual Report
Professional Engineers' Appointments Bureau
Proposed European Rail Tariff System
Royal Aeronautical Society

NEWS AND NOTES—
American Engineering News ... 329
Australian Engineering News ... 328
Books of Reference ... 318
British Patent Specifications. (Illus.) ... 335
British Standards Institution ... 326
Calendars and Diaries ... 334
Contracts ... 336
Forthcoming Engagements ... 336
French Engineering News ... 332
Industrial and Labour Notes ... 333
Launches and Trial Trips ... 334
Notes and Memoranda ... 334
Personal and Business ... 334
Technical Reports ... 319

THE DEFENCE OF THE ATLANTIC

NOT for many years has a naval question caused so much surprise and even alarm in this country as the Prime Minister's announcement in the Commons of the decision to appoint an American admiral as Supreme Commander of the North Atlantic naval forces. Some statement on the proposed organisation of Command in the naval theatres of war had no doubt become necessary because of the prevailing reports and rumours from abroad, but it is much to be regretted that a highly important decision of this nature should have been announced before the details of the new organisation had been worked out and decided. The Prime Minister had clearly had neither the time nor the opportunity to study all the implications involved. Nor was he encouraged to deal with the essentials of the problem by Mr. Churchill's supplementary questions—natural questions, which were in everybody's mind: "Were there no British admirals capable of discharging these functions? Does not Great Britain lie at the very key of all communications across the Atlantic with Europe? Are not the sea approaches to our island in the event of submarine attack vital to our life?" Faced with those questions, the Prime Minister could only reply that "he would look into the matter," and it was not until the following week that he was able to present to the House a reasonably clear picture of the new organisation and to deal, to a limited extent, with the three most important considerations involved: Is this new command necessary? Will it enhance the ability of the navies of the Atlantic Treaty powers to protect troop transports and supply ships on passage to and from this country and Western Europe? Is it strategically and tactically sound? In his explanatory statement, Mr. Attlee emphasised that experience in the last war showed that a single command was required in the Atlantic, which could allocate forces to different areas as necessary and this must be accepted as the opinion of the Admiralty and the Naval Staff. It is, however, clear from debates in the House of Lords and letters to the Press that this is not the view held by several naval officers of great authority and experience. In this connection we are particularly impressed with the evidence of Admiral of the Fleet Viscount Cunningham, and Admiral of the Fleet Lord Tovey, who served at the height of the submarine campaign in the last war as Chief of the Naval Staff and Commander in Chief, Home Fleet, respectively, and who both categorically deny that any such conclusion can be drawn from our war experience. These distinguished officers feel that the Atlantic area is too large for one command and that there is no need for changing the excellent organisation developed in the last war—with the United States Navy responsible for the Western Zone and the British Navy for the Eastern, each Navy keeping in the closest touch with the other.

It has been argued in favour of a single command that we shall have to conform to the mobility of the enemy's attacking forces and the shifting scenes of his main offensive effort, but there seems no reason why this cannot be done under the direction of the Joint Chiefs of Staff or by the "Standing Group"—the equivalent body (which includes French representatives) under the North Atlantic Treaty Organisation. As Admiral of the Fleet Lord Chatfield points out, Britain and the United States have a combined responsibility in the Atlantic, but it is not what could be called a combined operation. It is not a battle with a hostile fleet that is envisaged, requiring a tactical combination of our two navies. The problem is to meet a threat to our merchantmen from submarines and surface raiders—a strategical, not a tactical, operation. And the movement of ships and aircraft to meet an emergency of this kind off New York or in the Caribbean is not one to be arranged by an officer in the East or West Atlantic, but by the Joint Chiefs of Staff or their representatives. Dealing with the area and responsibilities of the new command, the Prime Minister explained that the Supreme Commander would exercise general strategical control over all the forces in the North Atlantic Ocean—other than British and European "coastal waters"—which are allotted to him by the North Atlantic Treaty powers. The North Atlantic Ocean will include an eastern and a western area, controlled operationally by a British and American admiral, respectively. The British admiral is to be the Commander-in-Chief, Home Fleet, who will act in association with the Coastal Command of the R.A.F., and be in operational command of all the naval forces in his area of the North Atlantic Treaty powers. The command in home waters is to be exercised by the Commander-in-Chief, Portsmouth, who remains under the general strategical control of the Admiralty—the position hitherto of all British Commanders-in-Chief. Mr. Churchill seemed content to leave what he called "this very complicated statement" for further study and possible debate but was subsequently moved to protest strongly when Mr. Attlee made it clear, in reply to further questions, that the Supreme Commander would have power to transfer forces from the eastern area to the western area of his command. Our life depends on the maintenance of the sea approaches, Mr. Churchill retorted, and a decision of this kind could only have been made in the last war after discussions between the governments and careful consideration by the Joint Chiefs of Staff.

But it all seems very unnecessary and unsafe to remove from the Admiralty the general strategical control of anti-submarine and anti-surface raider operations in the Eastern Atlantic and hand it over to an American officer located at some unknown place. We are not told where: but as he is to be guided in his general supervision by the "Standing Group," he will presumably be in close personal contact with that Group—in Washington or New York?—and not in a ship in the middle of the Atlantic. Is it intended that the Admiralty should wait for instructions from this officer before dispatching an aircraft carrier and destroyers or other anti-submarine forces from the Home Fleet to deal with a concentration of enemy submarines reported in the approaches to Gibraltar? Or would the Commander-in-Chief Mediterranean—who is not under his orders—try and deal with this threat independently of the Admiralty? Or, again, the Supreme Commander may have ordered his subordinate, the Commander-in-Chief Eastern Area, to dispatch a cruiser force to deal with a surface raider off the Azores, just as news is received by the Admiralty of the presence of a powerful raider north of the Shetlands, making for the Atlantic. What is the Admiralty to do? And how is the Air Officer Commanding Coastal Command to act in these circumstances? Is he to wait for a request from the Supreme Commander for aircraft to be sent to the Azores or co-operate with the Admiralty and concentrate on the raider off the Shetlands? It is questions such as these—urgent questions requiring urgent decision—which need consideration when discussing the necessity for the new command, rather than the alleged need for quicker action in

transferring forces from the eastern to the western area or vice-versa. The immediate problem is not, indeed, whether a Supreme Commander is or is not required, but rather the urgent need for many more effective anti-submarine vessels, capable of dealing in any possible threatre of war with the modern submarine, with fast underwater speed; and for anti-submarine detection methods which will locate the new submarine proceeding at 25 knots at a depth of 100ft, 200ft or even 300ft. This much can, however, be said without qualification. Given the need, or even the desirability for the new command, it is not national pride nor the overwhelming preponderance of the United States over the British naval forces which will influence the British public in welcoming the officer who is to hold the appointment, but the assurance that he is the best man for the job.

STEELS AND ALLOYS FOR GAS TURBINES

BEFORE the 1939–45 war, progress in the development of metals resistant to creep at high temperatures was mainly due to the demands made by designers of chemical reactor vessels, power station plant and, in particular, of steam turbines. The evolution of the modern steam turbine raised in the minds of engineers the possibility of constructing gas turbines, but for many years the idea was not worked out efficiently owing to the lack of suitable materials of construction. Progress in the development of the turbo-supercharger, jet engine and gas turbine for aircraft, accelerated by wartime demands, involved the production of new materials resistant to high temperatures. At very short notice it became necessary to supply steels and alloys which would resist conditions far beyond those possible with the materials available at the beginning of the war. Intensive research in this country and co-operative investigation in America, carried out on a scale commensurate with its vast resources, produced materials to meet the immediate requirements; but, after the war, there remained a need to consolidate the position, to confirm and improve the qualities of the accepted materials, and to make a selection for further development from the large variety of complex compositions which had been proposed and tested. There was an obvious requirement for closer understanding between the designer, the manufacturer and the research metallurgist, and this was recognised in America by the American Society for Testing Materials, which, in June, 1946, organised a symposium on "Materials for Gas Turbines." The American symposium rendered a useful service to all interested in the new high-temperature alloys; but four years later the time was evidently ripe for a fresh review of the position.

The symposium on "High-Temperature Steels and Alloys for Gas Turbines," held by the Iron and Steel Institute on February 21 and 22, 1951, was planned on a wider basis and covered every aspect of the subject—that of the user, the supplier and the research investigator. The mechanical properties of suitable steels and alloys were recorded in detail, including their creep and fatigue characteristics. The problem of high-temperature oxidation in the gas turbine was discussed with special reference to the products of combustion and the impurities which may be present in the fuel. Attention was given to new problems in connection with the extended use of welding in the construction of a gas turbine plant, and to the provision of welding electrodes of improved composition to give the necessary strength at high temperatures while avoiding any tendency to crack formation. The symposium included a survey of machining techniques required for the austenitic and ferritic steels used for gas turbines, and, in view of the difficulty of machining many of these steels and alloys, casting methods received much attention, especially the "lost-wax" method of precision casting. This method of casting, applied to the manufacture of nozzle guide vanes and turbine blades, offers such great possibilities of rapid and economical production in comparison with machining from bar stock or forgings that every effort is being made, by close control of the process, to guarantee dimensional accuracy, soundness and avoidance of surface defects, though some improvement in the fatigue strength of castings and of their resistance to thermal shock may be required to establish their merits conclusively.

The organising committee, with Mr. D. A. Oliver as chairman, is to be congratulated on having been able to enlist so distinguished a team of contributors to the symposium, which was appropriately preceded by the fifth Hatfield Memorial Lecture by Air-Commodore Sir Frank Whittle. Dr. Hatfield was one of the pioneers in meeting the demands of the steam turbine and contributing to the early development of gas turbine materials. Sir Frank Whittle, of course, was a pioneer in their application. The production of gas turbines of larger size and longer life for land and marine purposes has raised problems of obtaining the required properties in larger masses, and of the need for economy of "strategic" materials in those parts of a gas turbine where the temperatures, though high, are not sufficiently high to require the use of the highest grade of heat-resisting materials. It is important in designing an installation for large-scale production that the probable availability of alloy elements in the quantities required should be kept in mind. Designers can utilise materials to better advantage, and so help to conserve alloys and, incidentally, to reduce costs, by taking all possible steps to avoid high peaks of temperature. In a survey of gas turbine materials the metallurgical picture is liable to change rapidly in the future as in the past; but this symposium has served to consolidate the present position, and to provide a basis for fresh developments and a pointer to the most favourable direction in which progress can be made.

THE DESIGN OF AIRCRAFT RUNWAYS

THE design of aircraft runways has become a subject for detailed technical study only quite recently. That study has had to be developed since the war, owing to the increased size and wheel loads of aircraft, which have led to the gradual evolution from grass-surfaced airports to the substantial runways which are constructed to-day. Two papers presented last week at the Institution of Civil Engineers gave rise to an interesting discussion on runway design, which indicated the progress which has been made in this field, and the problems which remain to be solved. It is evident that all existing design procedures are open to criticism, and a great deal of work remains to be done to evolve more generally accepted design methods. Concrete and bituminous surfacings were first employed rather as a protection against abrasion than as load-supporting structures, but later, as wheel loads increased, heavier runways became necessary, and it was at that stage that the full complexity of the problem, involving the interaction of the runway and the subgrade, began to be appreciated. Similar problems are, of course, encountered in road construction, and research is along similar lines, but the bearing capacity required is less, and other factors, such as the riding quality of the surface, become more important. As an example of the increase in aircraft weights, the Handley Page "Hannibal," a typical pre-war airliner, had a weight of about 12 tons; the weight of a comparable modern aircraft is now about 40 tons, and the "Brabazon" weighs 135 tons. Tyre pressures have increased considerably; the tyre pressure of the "Hannibal" was about 35 lb per square inch, compared with about 80 lb per square inch for an air liner to-day, the tyre pressures of modern aircraft ranging from 50 lb to 150 lb per square inch.

The first of the two papers mentioned above, "Engineering Factors Influencing the Adoption of Rigid and Flexible Pavements," by B. H. Knight, gave a critical survey of existing design methods, which were classified as purely empirical, empirical methods using a soil strength test, methods involving both theory and experience, and the purely theoretical approach. The effect of variation in the moisture content of the subgrade was discussed, and a comparison made between rigid (or concrete) and flexible (or bituminous) runways. The second paper, "Testing Runway Foundations and Pavements," by J. A. Skinner, described plate bearing tests and subgrade tests, and was based on work recently carried out by the Air Ministry. A relationship between load and plate size from which a load classification system could be deduced was given. It was evident from the discussion which followed that every standpoint was open to criticism. For instance, the well-known California Bearing Ratio method of design was criticised by Dr. Knight and upheld by speakers in the discussion. The theoretical work of Fox in this country, of Burmister in the United States, and of Odemark in Sweden was criticised as being too abstruse and of little practical value in design at its present stage. At the same time, views were expressed that an ideal design method should be based upon the scientific background developed by those authorities, and that the question could not be reduced to the compass of a formula, since the variables were far too numerous. The relative merits of rigid and flexible runways were debated without finality, and it was also a matter of conjecture how much future developments in aircraft design would influence runway construction. The test results given by Mr. Skinner were, however, a valuable step towards providing a comprehensive load classification. One of the speakers noted that unless there was some method of re-

lating the top pressure of the all-up weight of an aircraft with the strength of existing runways, it was difficult for an operator to feel confident that his aircraft would not be "warned-off," as it were, when a runway began to show signs of failure. The problem was not entirely one of runway design. It might also be convenient to modify the characteristics of aircraft to get more favourable runway conditions. Efforts had been made by B.O.A.C. to arrive at a mathematical treatment to assist this comparison of loads, which was near enough to the truth to judge whether it was worth while putting eight small wheels on an aircraft instead of two, as had been done with the De Havilland "Comet."

The value of full-scale tests in problems of the nature of runway design, is by now well recognised. There can be little doubt that if the full-scale airfield investigations planned by a committee of the Ministry of Aircraft Production in 1944 had been started, valuable results would by now have been available. Unfortunately, that work was not carried out. Another factor which hampers progress to-day is the lack of constructional work, particularly in building roads. Several developments in constructional practice were noted in the discussion, however. One of the drawbacks of concrete slab construction is that the corners of the slabs are much weaker than the centres; methods of improving the corner strength by the use of dowels, or by constructing two layers of slabs, present interesting possibilities. The use of prestressed concrete also merits close attention. However, these developments all depend upon the basic approach to design, and it is evident that further research, perhaps along the lines proposed in 1944, is essential if a rational treatment of runway design is to be evolved.

Obituary

A. H. PEPPERCORN

THE death of Mr. Arthur Henry Peppercorn, which occurred at Newbury, Cantley Lane, Doncaster, on Saturday last, March 3rd, will be deeply regretted, especially by railway engineers. He was the last Chief Mechanical Engineer to be appointed by the London and North Eastern Railway, prior to nationalisation, and had spent the whole of his working life in the service of the L.N.E.R. and its predecessors.

Arthur Henry Peppercorn was born at Leominster, Hereford, on January 29, 1889, and received his general education at the Hereford Cathedral School. In 1905 he began a premium apprenticeship, under the late H. A. Ivatt, at the Doncaster works of the Great Northern Railway, and during his years there studied at the Doncaster Technical College. After completing his apprenticeship, Peppercorn gained further experience in the G.N.R. locomotive running sheds at Colwick and was subsequently appointed an assistant to the District Locomotive Superintendent at Ardsley and, later, at Peterborough. The first World War interrupted his career with the Great Northern. Peppercorn served in France in the chief mechanical engineer's department of the Royal Engineers, and before the end of the war was appointed technical assistant to the chief mechanical engineer in the Directorate-General of Transportation, France.

As soon as he was demobilised Mr. Peppercorn returned to the G.N.R. to become district locomotive superintendent at Retford, and soon afterwards he went back to Doncaster as assistant-in-charge of the wagon shops. His next appointment, in 1921, was as assistant to the carriage and wagon superintendent at Doncaster and, with the grouping of the railways in 1923, he became carriage and wagon works manager at Doncaster, L.N.E.R.; four years later he was appointed to a similar position at York, where he remained until 1933.

In that year Mr. Peppercorn came to London as assistant mechanical engineer at the Stratford works and in 1937 he became locomotive running superintendent of the L.N.E.R. Southern Area. But the following year brought his promotion to the post of mechanical engineer, North Eastern Area, at Darlington. Mr. Peppercorn returned to Doncaster—for the second time—in 1941, when he was appointed to the dual position of assistant chief mechanical engineer of the L.N.E.R. and mechanical engineer, Doncaster. Four years afterwards he relinquished the latter office to give closer assistance to Mr. Edward Thompson, the Chief Mechanical Engineer, and to take charge of the department in Mr. Thompson's temporary absence. When Mr. Thompson retired at the end of June, 1946, Mr. Peppercorn succeeded him as C.M.E. and on nationalisation, became Chief Mechanical Engineer in the Eastern and North Eastern Regions of British Railways. He retired from that position at the end of 1949 after forty-four years in railway service. Mr. Peppercorn was a Member of the Institution of Mechanical Engineers and was awarded the O.B.E. in the Birthday Honours of 1945.

SIR P. MALCOLM STEWART, BART.

SIR MALCOLM STEWART, Bart, who, as noted in last week's issue, died at Sandy, Bedfordshire, on February 27th, was among this country's foremost industrialists. He will be particularly well remembered by his work as Commissioner for Special Areas in England and Wales from 1934 to 1936.

Percy Malcolm Stewart, who was the second son of the late Sir Halley Stewart, was born in 1872, and was educated at the Royal High School, Edinburgh, and King's School, Rochester. Although his business career began with James Fox and Co., a firm of barge builders and lightermen, in Limehouse, by far the greater part of it was spent in the cement and brick industries. At the beginning of this century Sir Malcolm joined his father in the firm of B. J. Forder and Son, brick and cement manufacturers, of which he became manager. A few years later the company disposed of some of its interests to British Portland Cement Manufacturers, Ltd., and Stewart was appointed a managing director of the latter firm. Subsequently he became president of Associated Portland Cement Manufacturers, Ltd., and British Portland Cement Manufacturers, Ltd., and was also chairman of the London Brick Company, Ltd., which had become associated with B. J. Forder and Son and a number of other brick manufacturers. Sir Malcolm was responsible for the formation of the Cement Makers' Federation in 1918 and served first as chairman and later as its president. For two years, during the first World War, he was Director of the Government Rolling Mills at Southampton for the Ministry of Munitions.

There were many industrial and philanthropic schemes which benefited not only by Sir Malcolm's business ability and wise guidance but also by his generosity. When the difficulties of the "special areas" of England and Wales were most acute, Sir Malcolm readily accepted the unpaid post of Commissioner, a task to which he devoted abundant energy. His services, which led to a revival of industry in those areas, were recognised by the conferment of his baronetcy in 1937.

SIR JAMES PRINGLE, K.C.B.

As briefly recorded in our last issue, the death occurred, in London, on February 27th, of Sir James Pringle, who was Director of Electrical Engineering at the Admiralty from 1937 to 1945. James Scott Pringle was born on July 21, 1876, and was educated at Watford Grammar School and at the Central Technical College of the City and Guilds of London Institute.

His first appointment in electrical engineering was as a draughtsman with Evershed and Vignoles, Ltd., and during his two years with that firm, Pringle assisted in experimental work associated with the design of electrical instruments and signalling apparatus. From November, 1898, until the beginning of 1902, he was engaged as an engineer in the London office of R. W. Blackwell and Co., Ltd., and he then joined the staff of Crompton and Co., Ltd. For a few months Sir James was at the firm's Chelmsford works, but later he became manager of the Manchester branch, which position he held until May, 1903. He then became Deputy Borough Electrical Engineer of Salford, for a short period.

Towards the end of 1903 Sir James joined the Admiralty service and he was appointed to take charge of electrical engineering work in the dockyard at Malta, and subsequently at Gibraltar and Rosyth. After the first World War Sir James became Assistant Director of Dockyards at the Admiralty and, in 1937, was promoted to the position of Director of Electrical Engineering. As principal electrical adviser to the Board of Admiralty, he was responsible for the design and equipment of electrical installations in H.M. ships throughout the period of the second World War. Sir James retired from the Admiralty in 1945 and for some time thereafter was engaged in consulting work for the Metropolitan-Vickers Electrical Company, Ltd.

Sir James, who was created K.C.B. in 1943, was a Fellow of the City and Guilds Institute, an Honorary Fellow of the Imperial College of Science and Technology and a Member of the Institution of Electrical Engineers, to the Council of which he was elected in 1940. He was also a vice-president of the Institution of Professional Civil Servants.

EDGAR ALCOCK

WE have learned with regret of the death of Mr. Edgar Alcock, which occurred at 23, Park View Crescent, Roundhay, Leeds, on Friday last, March 2nd. Mr. Alcock was chairman and joint managing director of the Hunslet Engine Company, Ltd., Leeds, with which firm he had been actively associated for nearly forty years.

Edgar Alcock was born at Macclesfield, on February 7, 1877, and received his general education at Christ Church School, the Old Collegiate School, and King Edward VI Modern Grammar School, Macclesfield. In 1892 he began an apprenticeship in the Horwich Works of the Lancashire and Yorkshire Railway Company, under the late Sir John Aspinall, and for two or three years after its completion held various positions in general engineering works. In 1898 Mr. Alcock rejoined the Lancashire and York-

shire Railway as an outdoor assistant to the Chief Mechanical Engineer, in which position he continued until 1904. He then went to Beyer Peacock and Co., Ltd., Gorton, as assistant works manager, a post he occupied for the next eight years, which covered the early development period of the Garratt locomotive. In 1912 Mr. Alcock joined the Hunslet Engine Company, Ltd., as works manager and served that company with great ability for the remainder of his life. Soon after the first World War he became general manager and was subsequently appointed to the board of directors. He succeeded the late Mr. Alec Campbell as chairman of the company in 1941 and continued to hold also the office of joint managing director. Mr. Alcock was a Member of the Institution of Mechanical Engineers and a Member of the Institution of Locomotive Engineers. He also took a leading part, for many years, in the work of the Locomotive Manufacturers' Association.

A. J. LEYLAND

We have learned with regret of the death, on February 26th, of Mr. Arthur James Leyland, joint general manager of Automatic Telephone and Electric Company, Ltd., Liverpool, and a director of British Telecommunications Research, Ltd. Mr. Leyland, who was fifty-two, was educated at Wigan Grammar School and at Manchester University, where, in 1920, he obtained the degree of B.Sc. Tech. with honours in electrical engineering. His early years in the telephone manufacturing industry were spent with the Peel Conner Telephone Company, Ltd.—which was later taken over by the General Electric Company, Ltd.—of Salford and Coventry.

Mr. Leyland joined Automatic Telephone and Electric Company, Ltd., in 1923 and for some years was closely concerned with the design, manufacture and installation of automatic telephones, including the supply of director equipment to the London network. Subsequently he was engaged in furthering his company's overseas interests and became successively resident engineer in Buenos Aires, Antwerp, Poland and Lithuania. From 1934 to 1939 Mr. Leyland was European technical engineer for telephone schemes undertaken by the company in Belgium, Poland, Lithuania, Denmark, Latvia and Russia. He was appointed chief engineer at the Liverpool works in 1939, and four years later was elected a director and became general manager. Mr. Leyland was elected an Associate Member of the Institution of Electrical Engineers in 1925 and was transferred to full membership in 1944.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

DETERMINATION OF CRITICAL LOADS BY ENERGY METHODS

Sir,—The article by Mr. Brisby on "The Determination of Critical Loads by Energy Methods" in your issue of January 19th, page 82, was most interesting and also impressive from the point of its presentation. Although there is nothing new about applying energy methods for the determination of critical loads, it was the approach to the subject matter, in particular a sufficient number of explanatory diagrams, which made reading the article a pleasure.

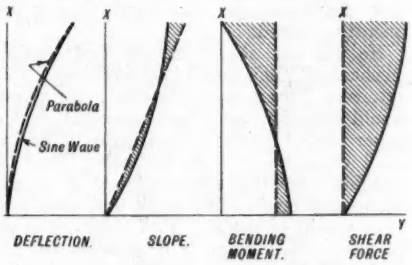
Mr. Brisby shows, by means of several examples, that various degrees of accuracy can be obtained for the crippling load of a slender strut, but a word of explanation on the relative merit of using either :

$$\Delta U = \int \frac{M^2 dx}{2EI} = \int \frac{P^2(\delta - y)^2}{2EI} dx, \text{ or}$$

$$\Delta U = \frac{EI}{2} \int \left(\frac{d^2y}{dx^2}\right)^2 dx$$

seems to be desirable.

It may be instructive to know that both the above expressions are exact only as long as the correct form for the deflection curve is used. When working with the help of an



approximate deflection curve, however, the first expression, which is dependent on y will give a more accurate result than the second expression which depends on (d^2y/dx^2). This is borne out by the fact that in selecting a deflection curve y can usually be determined more accurately than its second derivative d^2y/dx^2.

The figure above illustrates this in a very striking manner. Two deflection curves are drawn together, one a sine wave, the other a parabola. Beside them are shown the curves resulting from successive differentiation, indicating by the shaded areas the error in each case.

W. H. Mann

London, N.W.3, March 3rd.

ENGINEERING INSTITUTIONS

Sir,—An engineer usually joins an institution either in order to enjoy the status thus professionally afforded him, or for the benefit he obtains from the proceedings; this benefit may be in relation both to engineering problems and practice and to the social amenity of contact with men of similar training and outlook.

The three great institutions cover thoroughly the former case and on occasion function in respect of the latter case; but the many smaller institutions, very much alive though narrower in their fields, cater much more effectively for the latter case.

To bring under one huge institution the whole of the wide scope of the engineering field would, in all probability, be as fatal as the dead hand of nationalisation.

Kenneth H. Leech,
M.I.C.E., M.I.Loco.E., M.I.R.S.E.

Chippenham, March 2nd.

Sir,—The subject matter of a letter appearing under this heading in your issue of March 2nd calls for immediate questioning with particular regard to the lines of demarcation drawn between the various branches of engineering practice.

Such divisions could only be arbitrary, since the fundamentals of engineering science are included in the curriculum of any branch of engineering.

Is an electrical engineer unaware of the extent of the mechanical tension in the overhead cables suspended between pylons? Is a civil engineer incapable of seeing that an electrical system is in danger of being overloaded? Let us hope that they are not so badly informed, and, indeed, we will be less likely to do so when we think of civil engineers investigating the aerodynamic aspects of large suspension bridges or making provision against electrolytic decomposition in marine work.

Accordingly, one institution with appropriate divisions could be more representative of all branches of the engineering profession than several institutions whether comprising divisions within themselves or not. Though engineers are to varying extents specialists, they must also retain the attributes of a G.P.

May I conclude by respectfully drawing the attention of the writer of the aforesaid letter to the first part of the 1828 Charter of the senior Institution. There we see that the latter's principal *raison d'être* is for the "general advancement of mechanical science," and subsequently among other listed items, "the construction and adaptation of machinery." It is to be regretted that the term "civil" as applied to engineering has come to be accepted in a much narrower meaning than originally intended.

C. P. Goodwin

Falmouth, March 4th.

Literature

SHORT NOTICES

Principles and Use of Surveying Instruments. By S. Clendinning, A.M.I.C.E. London: Blackie and Sons, Ltd., 66, Chandos Place, W.C.2. Price 15s.—This volume is one of two in which it is intended to give in a limited compass the basic knowledge in the theory and practice of plane surveying, which is most commonly required by civil engineers, and which is required by students taking the associate membership examination of the Institution of Civil Engineers. That section of the subject dealing with instruments has been treated separately in this volume (the title of the companion volume is "The Principles and Practice of Surveying"), in which most of the common types of surveying instruments and equipment are described and illustrated. A good deal of space has been given to instrumental adjustments, although the text has been limited to the minimum necessary for the syllabus.

Climate in Everyday Life. By C. E. P. Brooks, D.Sc. London: Ernest Benn, Ltd., Bouverie House, Fleet Street, E.C.4. Price 21s.—A brief, general description of the climatic conditions of the world is given in this book, which is intended to serve as an introduction to the applications of climatology to industry. The book is divided into three parts, the first of which describes types of climate, their effect on various public services, and how to site and design houses and factories to suit weather conditions. The second part has three sections, one on the effect of heat and humidity on manufactured goods, one on the smoke evil, and one on the incidence of various types of storm. Part III discusses heating and air-conditioning, clothing and various artificial weather controls. There are appendices of climatic tables and measures of humidity and the text is accompanied by numerous diagrams and tables.

The Highway Engineer's Pocket Book. By F. G. Royal-Dawson, M.I.C.E. London: E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 12s. 6d.—This little book consists essentially of a set of tables of setting out data for highway transition curves. The author has arranged these tables with the aim of giving the bare essentials for setting-out curves in the simplest way in the field. The first part of the book consists of explanatory matter, with brief notes on types and properties of transition curves, and with references to more detailed theoretical explanations. There are then explanations of the tables with examples of their use. The tables are based upon the lemniscate transition curve and should enable both horizontal and vertical curves to be set out quickly and easily. The pocket book should therefore be of much use to highway engineers for the design and lay-out of roads for fast traffic.

Mechanical Engineers in the Process Industries

INSTITUTION OF MECHANICAL ENGINEERS

AT a general meeting of the Institution of Mechanical Engineers held on Friday, March 2nd, a paper, of which the following is a short abstract, was presented and discussed :—

MECHANICAL ENGINEERS IN THE PROCESS INDUSTRIES

By W. F. CAREY, M.Eng., M.I.Mech.E.*

The mechanical engineering curriculum seems to have grown out of experience gained in the fabrication of all sorts of objects; the manner in which all engineers are trained in strength of materials, theory of machines, drawing and design, is a reflection of this. As the industry has grown the curriculum has been enlarged to include subjects such as heat engines, hydraulics, steam turbines, &c. This method of education certainly allows manufacturers to design such appliances so that their performance can be closely guaranteed.

However, a large proportion of mechanical engineers serve a newer group of industries known as the process industries (chemicals, iron and steel, foodstuffs, &c.) as well as the manufacturers of the machinery involved in these industries (grinding mills, heat exchangers, driers, de-dusters, &c.), where the precision of design is as yet comparatively low. Owing to the lack of a proper understanding of the principles involved, expensive over-design is common. Fundamentally, no greater knowledge is required than is obtained in most pre-university instruction in physics and chemistry. The methods of translation of these principles into engineering devices, however, are new, and the necessary instruction can be obtained from simple experiments chosen to illustrate the laws governing the transfer of heat, the analogous process of the transfer of matter and the settling of small particles in a fluid under gravity or centrifugal action. These experiments could best be included in the university curriculum as an interim measure, or, because it may be undesirable to extend the experimental course, suitable experiments can be devised for the new entrant into the process industries. Experience of this latter method has been obtained by the author, and it has been found preferable to the old "sink or swim" methods. If the proposal to install such courses were adopted on a national scale some eight courses would suffice for Britain. As far as can be ascertained this proposal does not conflict with the national policies which are now being followed in educating engineers.

Course for Newcomers

The author's experience lies in the chemical industry and with the manufacturers of the equipment which it uses. Here the traditional method with young engineers has been to allow them a year or so to find their feet, but this wastes time and tends to consolidate existing practice, in that minds become ossified against inquiry into the underlying principles. In the last few years the effect of a month's course of instruction has been tried, comprising ten simple experiments designed to bring out the underlying principles upon which rests the design of the more important types of machine. The ten experiments described in the paper illustrate both this intention and the manner in which fresh fields of knowledge in mechanical engineering have now developed beyond the research stage, so that they can be taught to graduates who evince interest in the subjects. It will be found that when provided with appropriate instruction sheets students of Higher National standard can take the course with very little supervision.

It is suggested that this method of instruction might be widely applied throughout the process industries and might also be useful elsewhere.

The author, in presenting his paper, added that the main value of the course described was in demonstrating the manner in which natural processes underlay most industrial operations. There was great need for textbooks which explained the fundamentals simply, so that the knowledge could be applied more widely. If fundamental knowledge was disseminated among a sufficient proportion of personnel, it might be possible to ensure that mistakes in detail design were avoided. It was usually in the drawing-office and design stage that fresh types of knowledge were not applied properly to new developments, and costly failures frequently resulted.

He was not at all certain that straight mechanical engineering would accept this extension. It might well be that many people would consider the ideas expressed in the paper tended to dilute the practice of mechanical engineering. On the other hand, it was fair to say that certain aspects of straight mechanical engineering might find that those ideas would be useful. Two instances could be cited—the design of de-aerators and the design of catchpots to remove oil and water mixtures between the stages of reciprocating compressors.

The chemical engineer spent a considerable period in a university on chemistry and engineering subjects, and did not normally serve an apprenticeship. The present paper was concerned with mechanical engineers. When first writing the paper, it had seemed to him that it was important that this type of technology should, if it were to become really useful, be taught and considered by the universities. He was now inclined to think that this was rather a remote ideal and might take some years to achieve. He still thought that it should be followed, but he felt emphatically that it could not be done until it had been possible to interest lecturers in the universities in this type of subject. An early step might be a summer school held either at the research department of a research association or at some large industrial concern, and it was difficult to see how such a course could be introduced to a university in any other way.

Discussion

Mr. G. J. Williamson said that at the moment mechanical engineers did not get the opportunity to acquire the fundamental principles of the subjects which had been dealt with in the paper, unless they undertook advanced studies, and only the most brilliant students were able to do this, and in that process they acquired not only the elementary principles, but a vast amount of background and specialised knowledge, with the result that these men (relatively few in number) reached industry and were translated straight away into the higher technical positions. What was needed was to cater for the others. He was sure that the vast majority of mechanical engineers who entered the process industries were in the same position as he had been when he joined the Birmingham Division of Imperial Chemical Industries, i.e., completely clueless on such subjects as heat transfer, adsorption and de-dusting. This led, particularly in the initial stages, to the inefficient use of men who potentially were of much greater use. The management of I.C.I. had realised this fact, and all graduate engineers during their first few years with the firm spent a fairly lengthy period in his own department (which, for want of a better name, was called the Chemical Engineering Research Section). He confirmed the author's statements about the usefulness of the course described in the paper. During the past year or two, about fifty people had taken it at Birmingham, ranging from juniors straight from school with School Certificate qualifications to Honours graduates in engineering. He thought that the men who received the greatest benefit were those engineers with the Higher National Certificate or ordinary degree qualifications—i.e., the men who were employed as draughtsmen or as assistant engineers in the research sections.

Professor D. M. Newitt was sorry that the author had not confined the paper to a description of the very excellent experiments that was contained in it and left the educational matters for some further paper. The experiments were well described; they were, of course, not complete, and he did not think the author claimed that they were complete, but as far as they went they formed a very useful basis for dealing with the subject matter of the paper. The subject matter of the paper, as everyone knew, was chemical engineering and nothing else. The whole of the matters concerned with the design and the operation of the plant for the chemical industry were now known universally and in every country which had a production industry as chemical engineering, and the meaning of that term was fully appreciated. What they were concerned with was what ought to be done in order to produce men who were competent to design plant and operate it in the big process industries of this country. The proposal in the paper, as he understood it, was that one could take a man with a degree in mechanical engineering and give him a short course lasting one month (in which he carried out the experiments described), and then he would be trained as a process engineer and be competent to design and operate plant in industry. To that proposal, Professor Newitt said, he must register the most emphatic dissent. It had been his lot during the past ten years or so to endeavour to train young men for this particular purpose in his college. One method was to give them an undergraduate course of training which lasted four years, and the other method was to take a graduate in mechanical engineering or in chemistry and give him a post-graduate course lasting a minimum of one year, but usually two years, after which time it was considered that at any rate he knew the fundamentals of the subject and, after a period of employment in industry, would be competent as a chemical engineer (or, if preferred, a process engineer), able to assist in increasing the efficiency of plant and to increase the productivity of this country. To suppose that a mechanical engineer with one month's additional training could possibly do this was to stretch credulity to the very utmost limit.

The question was how these men so trained could be employed for the purpose that the author had outlined in the introduction to the paper. In this country, if there were any general method for designing and erecting a large plant (he was not talking now about small pieces of plant), it was to employ a team composed of a mechanical engineer and a chemist. By some people this was regarded as being the best method of dealing with a large enterprise. He thought it had been shown by many of the productivity teams that had been going round the world examining methods in other countries that, whereas in the United States of America productivity in the last ten years had increased by something like three times, in this country it had increased by only one and a half times. It might be inferred from this that the mechanical engineers and the chemists in America were very much better than they were in this country, but he did not believe that. The reason, he thought,

* Engineering division manager, Alkali Division Research Department, I.C.I., Ltd.

was that the team employed in this country was an incomplete team, lacking one element, namely, the chemical engineer, who was a necessary part of the team not only to lead it, but to make a contribution to the project in his own right. He felt this very emphatically. No greater disservice could be done to the cause of industry in this country than to try to ignore this method of improving productivity. Those who had had anything to do with the development of the large synthetic rubber factories in the United States during the war had seen there an example of an enterprise on the very largest scale that had to be started with very incomplete pilot plant data. He believed that that data had been hardly anything more than could be obtained from laboratory experiments. These huge synthetic rubber plants had been put up in not very much over a year and had gone into production, and that great achievement had been carried out by teams consisting of chemists, mechanical engineers and chemical engineers. A project of that sort could not be done in any other way. If that fact was ignored, the chance of improving productivity and efficiency in the industry of this country would be very much minimised.

Mr. C. E. G. Simmons said that he had derived great benefit from the kind of training described in the paper. In 1928, soon after leaving Cambridge, he had joined I.C.I., Birmingham, and worked for two years in the research department under the author. In those days it had seemed to him that there was little need for training of the kind advocated in the paper, because there had been a mass of experimental work going on in the research department, and he had felt that there was ample opportunity for young engineers and chemists to find out for themselves how things should be done by just keeping their eyes open. In his experience that organisation had given a better training than was possible from a course of planned experiments, because it seemed to instil a sense of urgency, personal responsibility and real purpose in the people who were working there. At that time he had not appreciated how it was all organised, but he would like now to pay a rather belated tribute to the author and his colleagues who had been responsible for an organisation which had enabled so many young engineers and chemists to work together in harmony on industrial developments. Those conditions had been nearly ideal for the rapid acquisition of practical experience in how to build and operate chemical plants. He agreed entirely with the author's advocacy of applying the engineering method to plant development in the chemical industry, but he wondered whether a month's course, performing ten set experiments, provided sufficient interest for newcomers—interest which seemed to be so very desirable when starting. An alternative might be for those who were anxious to advance this cause to exert themselves in persuading the managements to spend more money on plant development and at the same time to expound to them the absolutely essential need for experiments as the one and only means of avoiding expensive over-design. In this way, he submitted, more openings and more encouragement might be provided for the young chemist or engineer who was just embarking on such work.

Mr. J. E. Braham remarked that the introduction to the paper referred to expensive over-design as being common, but it made no mention of the by no means inconsiderable examples of under-design. It could be inferred from the author's remarks, too, that in the pre-process industries phase over-design was not common, but he felt sure there was plenty of evidence to show that there was, in fact, much over-design. The essence of the matter surely was that they were faced with more and more engineering problems to solve, problems which were of greater and greater complexity, and they were still without full knowledge of the fundamentals of the phenomena involved. The inevitable result was that there was both under-design and over-design, with perhaps naturally a tendency towards the latter as an insurance of performance up to the required level. The author had suggested that the series of practical experiments (which, incidentally, as described, seemed to be hardly calculated to bring home to the young engineer the problems arising from, for example, dirt films, the difficulties of correct sampling of gases and solids, maldistribution both of liquid and gas in packed towers, scale effect and size effect) would go a long way towards providing a solution. Although these experiments did, in fact, provide very valuable instruction for young engineers, he was afraid that the author's approach was an over-simplification of the problem.

He imagined that the proposals in the paper were directed primarily to the case of those mechanical engineers who would be engaged on research and design rather than on construction, operation or maintenance, and that they would be engaged primarily, so far as the interest of this matter was concerned, on the research into and design of specialised classes of equipment. If that were the case, it ought to be realised that it was very seldom that an engineer in his training period or in the early part of his career really knew what he was going to be doing in his industrial career. At the present stage of technical development, there was more and more to learn of greater and greater complexity, and unfortunately there was less and less available time because of military service and other things. It was therefore necessary to consider very carefully whether the form of instruction suggested by the author would result in the best use of the time available, although admittedly it was only suggested that it should take up a relatively small amount of time. In the case of a mechanical engineer who not only intended to be employed on research in the process industries, but who was in fact the right kind of man for such work, the really important thing was that he should be given a sound training in research technique and all that that implied—i.e., the ability to assess the requirements of a problem and properly to analyse the results of his research work. This brought him back to his earlier inference that the experiments described by the author seemed to require major elaboration to ensure that they brought home to the young engineer the many difficulties which arose in the practical application of the principles of fluid flow, heat and matter transfer and the commutation of solids, all of which were so important to the process industries and those plant and equipment manufacturers who were working in the same field.

Mr. H. Chilton said that he had carried out most of the experiments described by the author and he could testify from experience that they provided an interesting and effective way of learning the basic principles of some chemical engineering processes. Many other experiments on similar lines suggested themselves. He would mention only the problems associated with the pattern of fluid flow, which he felt were of more practical importance in the engineering industries than was generally recognised. A useful addition to the author's list might be a simple experiment on flow pattern in two dimensions. If the results could be checked by relaxation methods from hydrodynamic considerations, so much the better.

He also noticed that statistical conceptions had been neglected. This omission could easily be rectified within the framework of the programme outlined in the paper. For instance, if experiments 3 and 4 were always carried out under the same operating conditions and the student were provided with the results of his predecessors, he could be required to find :

(*a*) The mean value of the mass transfer coefficient.

(*b*) The standard deviation.

(*c*) The 95 per cent reliability limits.

(*d*) If his own result, or that of any previous student, was significantly (say, 95 per cent probability level) different from the remainder.

(*e*) The probability of the formula given for experiment 3 satisfying the results within, say, 1 per cent.

An exercise of this sort would be particularly useful because it would encourage the experimenter to inquire into the accuracy of his own work, which was perhaps the most important lesson that any research worker ever had to learn.

Mr. B. O. Walkley said that as engineers they were apt to regard the first few years of a man's life in industry as being largely devoted to increasing his technical ability, but it must not be forgotten that this period also required a radical change of mental outlook on the part of the erstwhile student. As a student his ability was tested periodically by setting him problems in his field of training and supplying him with all the necessary data to solve those problems. Usually no additional information was given to him. He merely put the data which he was given into some sort of pattern and produced the required solution—if he was lucky. On entering industry the position was quite different. He must find the information which was required to solve the problem, and this might not be easily acquired ; it might require a certain amount of research work to be done. Moreover, where information was available on the problem, he might find that there was, in fact, so much data that he had very carefully to sift it out in order to find what was the relevant data that he wanted. That was quite a different situation from the one to which he had been accustomed, and it required a certain period in which to allow him to settle down. The author had suggested a technique for teaching engineers the industrial applications of the fundamental laws of physics which they had probably learned in school or at the university, and therefore it did represent a very important step in enabling the engineer to settle down into the process industries.

Mr. Peck said there was another aspect of the paper to which he wanted to refer, namely, that in which the author said that no greater knowledge was required than was obtained in most pre-university instruction in physics or chemistry. This meant that the mechanical engineer who was going to work in the process industries wanted no more physics than he got in matriculation, and no more chemistry (usually one year) than he got in matriculation. This was a suggestion which was not in accord with the trend of the training of mechanical engineers in this country. He said this because there had been changes in the training of mechanical engineers in the University of London (and he spoke with some knowledge of the subject, as a Senator of the University of London),

and there had been introduced into the new syllabus of the B.Sc. in mechanical engineering a requirement that the mechanical engineer had to pass the Inter. Science examination. The ordinary Intermediate examination in mechanical engineering had gone. The trend of thought in academic circles was that the engineer should be more of a scientist.

Mr. Thompson remarked that the normal course in properties of materials, whether Degree or Higher National Certificate standard, was completely dominated by considerations of the strength of beams and general structural problems. But the man entering the process industries must know something of the properties of materials other than mild steel. Not only must he know something about other materials—for example, lead, plastics, ceramics—but he must know something of the thermal properties of materials, their expansion, their heat transfer coefficient, and that other property which was a combination of those, resistance to thermal shock. These were of tremendous importance to the process engineer, and it was not right to assume that they were already known by the mechanical engineer. The author's experiments dealt exclusively with what the chemical engineer called the unit processes. Personally, he was rather concerned lest they were making the mistake of thinking that by taking a mechanical engineer and adding to him a knowledge of the unit processes, they got a process engineer. To think that would be to make a great mistake, and it would be a mistake equally whether the man was being trained to design or to operate the plant. Operation could never be separated from design. Whether a man was going to design the plant or to operate it, knowledge of the materials was of paramount importance.

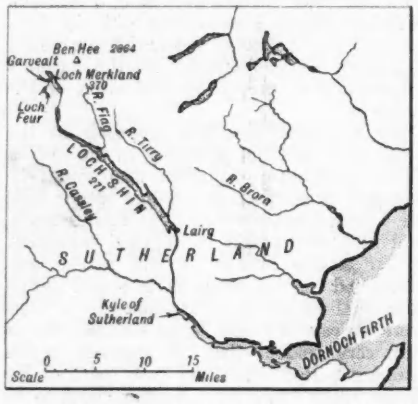
Mr. W. F. Carey, M.Eng., M.I.Mech.E., in a brief reply, said that possibly a number of contributors had somewhat misunderstood his intention. He did not feel that a month's course could possibly be a substitute for an education; it might, however, serve as an introduction, particularly in the case of mechanical engineers, to something which in its absence they might take many years to find out. Nor did he wish to claim, as others seemed to have claimed to some extent, that this particular type of technology was the prerogative of one kind of engineer or the other. It seemed that there was room for all of them, and there was really no need to raise that point. He could speak only as he saw things, and it had seemed to him that when mechanical engineers first came to I.C.I. and were faced with the difficulty of how their training could be linked up with that of the process industries, it was helpful to show them a number of experiments, because there was no better method of bringing home to people the reality of anything than by showing them the operation of natural processes. This formed a good introduction which would indicate to people that natural law ran through all the processes that they had to operate. It had certainly been found in I.C.I. that it did form a helpful method of training mechanical engineers. It had occurred to him that the same thing might be possible in other industries, if they felt that it was a good idea.

PURCHASING OFFICERS' ASSOCIATION: RAW MATERIALS SURVEY.—Three new titles—No. 4, "Coal" (2s.); No. 5, "Non-Ferrous Metals" (2s. 6d.), and No. 6, "Manufactured Abrasives and Industrial Diamonds" (2s. 6d.)—have recently been added to the Raw Materials Survey Series of booklets published by the Purchasing Officers' Association, 146a, Queen Victoria Street, London, E.C.4.

The Shin Hydro-Electric Scheme

THE North of Scotland Hydro-Electric Board has announced details of its Constructional Scheme No. 32, the Shin project, which will use the waters of Loch Shin and its tributaries, and the River Cassley, the River Brora and other streams in the County of Sutherland, for the annual production of about 167,000,000 units. The scheme will harness the water power resources of an area of 250 square miles, and is estimated to cost approximately £8,000,000. The work involved includes the construction of one main and five subsidiary power stations with an installed capacity of 44MW in the area shown in the accompanying illustration.

The main power station, which will be built on the north shore of the Kyle of Sutherland near Linsidemore, will have a capacity of 25MW. A tunnel 5 miles long will carry water to this station from Loch Shin, which, by a dam 1125ft



RIVER CATCHMENTS OF THE SHIN SCHEME

long and 39ft high at Lairg, will be enlarged to provide a storage capacity of 10,300 million cubic feet (equal to a storage of 50,000,000kWh). Provision will be made for the ascent of salmon above the dam.

One of the subsidiary power stations will be built near West Shinness Lodge on a new bay formed by the enlargement of Loch Shin. It will draw water from the River Tirry and its tributaries, and will have an installed capacity of 1·75MW. Further west and also on the north shore of Loch Shin, the Fiag station, with a capacity of 1MW, will be constructed. Water will be diverted by an aqueduct from the River Fiag to this power station. The Cassley station on the southern shore of Loch Shin near the western end will use water brought by tunnel from the upper Cassley and the streams which feed it. The available head is 371ft and the station's capacity will be 3·75MW.

There are two subsidiary developments to the north-west of Loch Shin. One consists of a dam to enlarge Feur Loch, an aqueduct and a power station with a capacity of 1MW situated on the southern shore of Loch Merkland near Garvault. The remaining station, Ben Hee, is to be on the opposite side of Loch Merkland and will have a capacity of 5MW. It will be fed from a storage loch formed by a dam which will join three small hill lochs.

Details of a new diesel generating station in Wick (Constructional Scheme No. 59), which will more than double the existing generating plant capacity in Caithness, have also been announced by the North of Scotland Hydro-Electric Board. The station will have a total installed capacity of 3·6MW, consisting of six 600kW diesel generating sets. Its construction, which it is estimated will cost £157,120, has been made necessary by the great rise in the demand for electricity in that county. The Board has already increased the capacity of its first generating station at Wick from 800kW to 1880kW, and of its generating station at Thurso from 743kW to 1043kW, but as a result of the progress made on the distribution scheme for the county the additional plant at these two stations is now insufficient.

Shortage of Electrical Power Capacity in West Germany

SOME of the difficulties that beset Germany owing to lack of power plant are referred to in a recent report from Reuters. According to this report West German industry will be faced by serious power supply difficulties in the next few years unless the generating capacity of public utilities can be raised by 4500MW and that of industrial power stations by 1500MW. This would necessitate investments of about 6400 million Deutsche Mark, of which 1000 million only could be put up by the electricity companies themselves, according to estimates by the electricity companies' association, which represents about 90 per cent of West German power plants. In 1946 the generating capacity of 3869 MW represented only about 71·5 per cent of installed generating capacity (5414 MW). This ratio of available capacity as compared with installed capacity was raised to 94 per cent in 1950, when they totalled 6497 and 6902 MW respectively, reflecting the progressive repair and resumption of operations by nearly all power plants. The 1950 peak in consumption, which occurred on December 21st, was 6160 MW and thus did not overtax the installed generating capacity. It represented an increase of 908 MW on the consumption peak of 1949.

At present, the report continues, the greatest operational problems are insufficient allocations and deliveries of hard coal. A spokesman of the Federal Ministry of Economics recently estimated stocks of coal at power stations at only 290,000 tons and said that the figure would have to be increased to 400,000–500,000 tons to ease the situation.

The total output of public utilities in 1950 amounted to 26,042 million kWh, as compared with 23,840 million units in 1949. Thermal generation accounted for 18,649 million units, or 71·6 per cent of the total output (including 12,272 million kWh of hard coal thermal generation). Hydro-electric generation made up a further 7030 million kWh, or 27 per cent of the total, and other power generation 363 million kWh (1·4 per cent).

It is expected that a construction programme, which will increase the installed generating capacity by about 2500MW, will possibly cover demand in 1951 and 1952. This programme is to be financed largely with the aid of E.R.P. funds. However, it is estimated that total consumption by the public utility grid and industrial stations, which amounted to about 37,000 million units in 1950, will have risen to 60,000 million by 1960. The *per capita* power consumption of the population, which amounted to 578 units in 1948 and to 682 in 1949, rose to an estimated 780 in 1950.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

PRESSBOARD FOR ELECTRICAL PURPOSES

No. 231 : 1950. This revised edition of B.S. 231 is mainly a reprint of the 1936 edition, but the opportunity has been taken to include tests for ageing in oil and resistance to compression and deformation. In view of certain difficulties and the extreme hardness of the pressboard itself, type IV pressboard is not now manufactured, and for this reason is no longer included in the Standard. Amendments have been made to the definitions and the complete revision is based on information supplied by the British Electrical and Allied Industries Research Association. Price 3s. post free.

FERROUS PIPES AND TUBES FOR PRESSURE VESSELS FOR USE IN THE CHEMICAL AND ALLIED INDUSTRIES

No. 1507/8 : 1950. This publication contains a comprehensive range of specifications for pipes and tubes manufactured from twelve types of steel covering mild steel, alloy steel and austenitic steel. In it full details are given of chemical compositions, mechanical properties, methods of test and tolerances in finished pipes and tubes. Price 10s. 6d. post free.

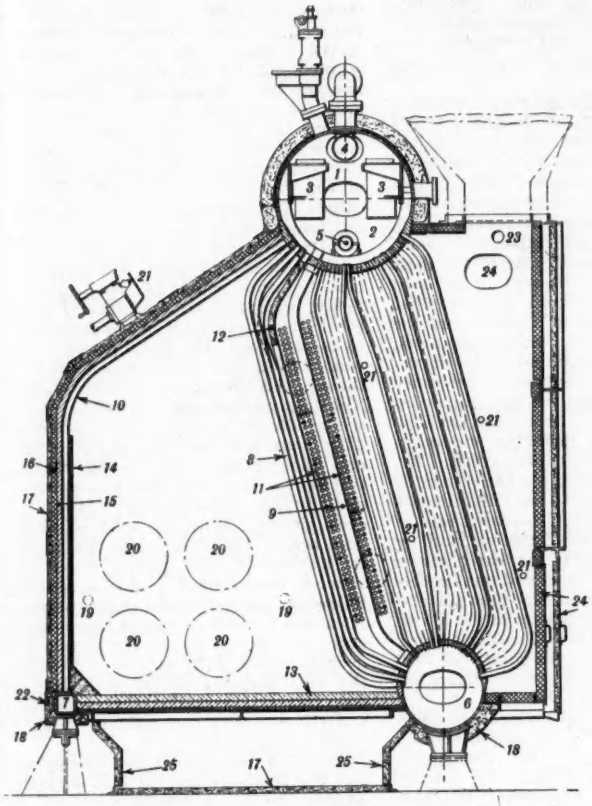
Two-Drum Integral Furnace Marine Boiler

THE 8500-ton fleet oiler "Punta Medanos," which was completed last year by Swan, Hunter and Wigham Richardson, Ltd., for the Argentine Navy, is engined by two sets of double-reduction geared turbines, built by the Wallsend Slipway and Engineering Company, Ltd. High-pressure superheated steam is supplied by two Babcock and Wilcox boilers, which were built under licence by the engine builders, and operate under Howden's system of forced draught in a closed stokehold.

The boilers, which are fitted with superheaters and tubular air heaters, are of the two-drum "integral furnace" design, which is a recent development of Babcock and Wilcox, Ltd., in the marine field, and is a simplified version of the double-furnace controlled superheat boiler. In the accompanying drawing it can be seen that the boiler consists of a single bank of tubes inclined at 15 deg. to the vertical, with an upper steam/water drum and a lower water drum, and differs widely in detail from all other types of two-drum boiler. The furnace side wall is of water-tube construction and the back wall can be either plain refractory or water cooled, according to the furnace rating.

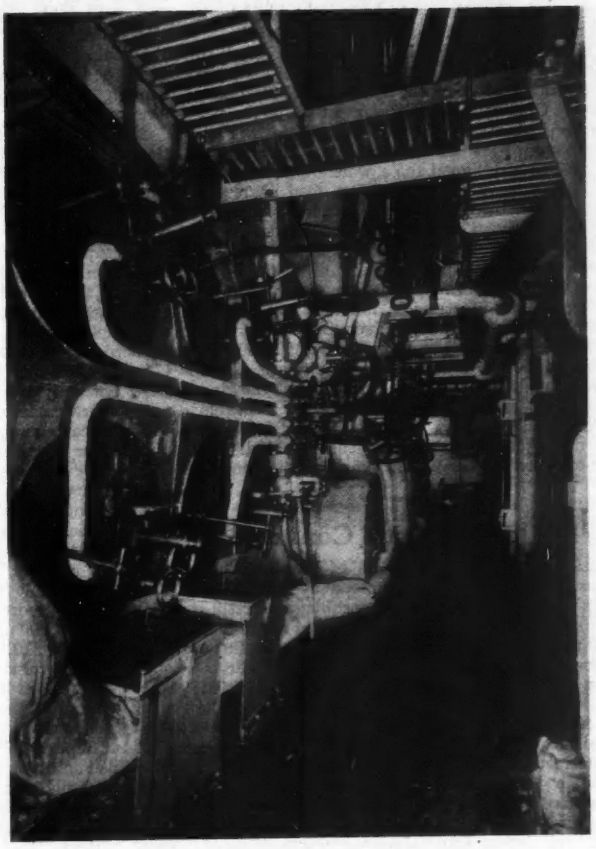
The furnace walls are of the company's usual stud-tube construction and consist of a single row of tubes with electrically welded studs; the front section of the furnace has these tubes completely covered by chrome ore, the rear section being exposed to flame. Chrome ore is used as the sealing medium between the tubes. The furnace temperature in the section nearest the burners is thus maintained sufficiently high to promote good combustion at low ratings with the lower grades of fuel oil. This construction offers extended heating surface for radiant heat absorption and reduces furnace maintenance. The furnace wall has a separate steam/water circuit, distinct from that of the main tube bank, the header at the base being fed by downcomers direct from the upper drum. The main bank, with superheater interposed, is similar to that of a standard single-pass header Babcock marine boiler, with 2in outside diameter tubes in the furnace rows, followed by 1¼in tubes in the rest of the bank. The superheater support plates are secured to 3in diameter water tubes running between the two drums.

The circulatory system, shown in our illustration, is a characteristic of this design of boiler. The lower part of the upper drum is divided to form an annular space and the mixed steam and water from the evaporating tubes is discharged into this space and thence into cyclone separators. The steam is released from the top of the cyclones passing into the dry pipe and the water is directed downwards into the main body of the drum where, as a bubble-free fluid, it passes to the downcomers which feed the bottom drum and the lower header of the water wall. With this separation of the drum water from the steam/water mixture the well-proved

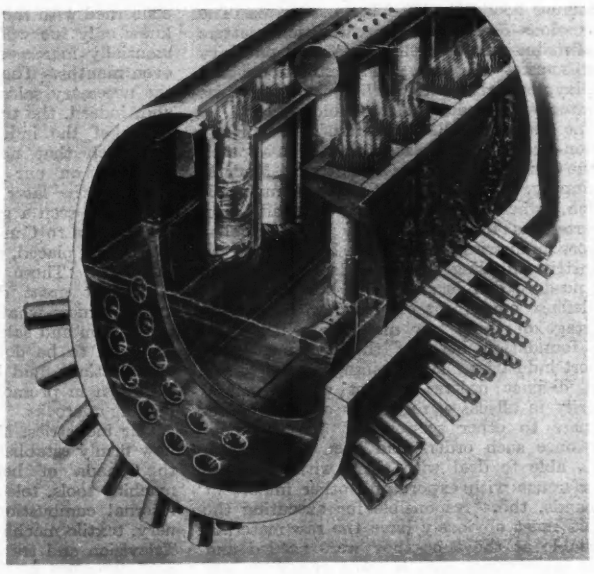


TWO DRUM INTEGRAL FURNACE BOILER

1. Steam and water drum
2. Steam cyclone baffle plates
3. Steam cyclones and scrubber elements
4. Dry pipe
5. Internal feed pipe manifold
6. Water pocket
7. Water wall header
8. Boiler generating tubes
9. Steam drum and superheater support tubes
10. Studded water wall tubes
11. Superheater tubes
12. Superheater chrome ore baffle
13. Furnace brickwork
14. Chrome ore
15. Plastic insulating cement
16. Insulating blocks
17. "Glass Silk" insulation
18. Lagging
19. Furnace inspection sight holes
20. Oil burners
21. Soot blowers
22. Handhole fittings
23. Smoke observation fitting
24. Access doors
25. Bottom air casing



OIL FIRING EQUIPMENT



DIAGRAMMATIC VIEW OF CYCLONE SEPARATORS

characteristics of the Babcock header type boiler are retained and it is impossible for any generating tubes to become downcomers or to be starved of water, irrespective of the boiler loading or of the rate at which this loading is varied. The absence of steam bubbles passing through the main mass of water in the upper drum prevents wide variation in water level when rapid manœuvring takes place, as there is no general collapse of water level when the oil burners are shut off, and conversely no appreciable rise in level when they are all lit up again. This simplifies the operation of the automatic feed water regulator and prevents the severe hunting which is unavoidable if there is a wide variation in the water level.

Each boiler has a heating surface of 6740 square feet with a superheater of 571 square feet, and a tubular air heater of 7540 square feet. Operating conditions are 400 lb per square inch steam pressure and 750 deg. Fah. temperature at the superheater outlet, the drum being designed for a working pressure of 455 lb per square inch. The feed water is heated by bled steam to a temperature of 300 deg. Fah. The overall boiler efficiency is of the order of 87·5 per cent on the higher calorific value of the fuel. The boilers are oil fired and the Wallsend-Howden equipment, which is shown in our illustration, includes two sets of Simplex oil-firing units, each capable of carrying full load, which is the equivalent of 110,000 lb/steam per hour from the two boilers. A full complement of Babcock standard soot blowing equipment is fitted to the boilers; retractable single-nozzle blowers for the furnaces, followed by multi-jet type units for the remainder of the evaporating banks and the air preheaters.

A Dollar Exports Convention

LAST week there was held in Eastbourne a Convention which was arranged by the Dollar Exports Board to discuss problems relating to exports to the dollar areas and to re-emphasise the importance of continued efforts in those areas. The Convention was attended by directors and executives of several hundred British firms, and, in view of the present new demands on British industry, there was naturally special emphasis given to the shortages of certain raw materials and to the requirements of the defence programme. During the plenary sessions of the Convention and the several sectional meetings which were arranged, speakers drawn from almost every section of this country's industries dealt ably with all aspects of sales and marketing of capital and consumer goods in the dollar countries. The discussions dealt not only with such matters as distribution and selling methods, publicity and market research, and exhibitions and display, but also with such important topics as after-sales service and stockholding.

The effect on dollar exports of the shortage of non-ferrous metals was referred to in a speech to the Convention by Mr. G. R. Strauss, Minister of Supply. He pointed out that raw materials which, when previously scarce, had been diverted as far as necessary to the dollar export industries, must now be diverted to industries fulfilling defence orders. The pressing need to double and treble our production of defence equipment coincided with a severe shortage of those raw materials which were the foundation both of the armament and export industries. Mr. Strauss went on to say that defence orders did not get automatic priority in all cases, regardless of their consequences to other sections of our economy. But once such orders had been placed with firms able to deal with them with the least interference with export and other important demands, those responsible for executing the orders must obviously have the raw materials available at the time they were needed and must have them even if, as a result, it was impossible to meet in full all the demands for dollar exports. The Minister went on to refer to the Orders prohibiting uses of copper and zinc, and to the principles which would be followed in licensing exports of the goods covered by the Orders. He said that the grant of those licences must depend on the conversion value of the goods proposed to be exported, the currency of the country for which the goods were destined, and the prospects of the export of the goods continuing when conditions became normal. It had been decided that, normally, the qualifying conversion factor in the case of exports to the dollar area or sterling Commonwealth countries must be at least fifteen times the value of the copper, zinc, or their alloys contained in the product and in the case of other countries a minimum of fifty times. The problem, however, Mr. Strauss observed, was one which could not be solved by the application of some rigid code. It was possible only to translate certain principles into rough working rules, sufficiently simple and clear to be administered by industry and the Government machine, and flexible enough to be adjusted to meet changing circumstances.

Another Government speaker at the Convention was Mr. Harold Wilson, President of the Board of Trade, who addressed the concluding session last Saturday morning. He said that, in this period of rearmament and defence effort, there must be no "kicking away" of that support of this country's economy which had been so painfully and laboriously built up over the past five years. One of the most encouraging aspects of the Convention had been the whole-hearted endorsement given to that principle by speakers from Canada and the U.S.A. Dollar exports, Mr. Wilson continued, were not only a programme equal in importance to rearmament; they were a necessary part of rearmament itself, for only by maintaining our dollar earning power could we hope to pay for the essential materials and other supplies needed to maintain production. Mr. Wilson went on to say that, in the early months of 1950, the impetus given to our dollar export drive by devaluation, by the increased rate of industrial activity in North America, and by the now tangible results of the early stages of the dollar export drive increased our exports from 128,000,000 dollars in the first quarter of last year to 210,000,000 dollars in the fourth quarter. The value of United Kingdom exports to North America in the fourth quarter of 1950 was, in fact, 81 per cent above the figure for the corresponding quarter of 1949.

Those exports in the fourth quarter of 1950, Mr. Wilson stated, were divided almost equally between Canada and the U.S.A. The figures of trade for Canada over the past few months had underlined another important development, namely, the growing success of British engineering industries in establishing themselves in that market. All who had been concerned with the building up of such a trade knew only too well that it could not be substantially increased in a matter of weeks or even months. The time required to establish the necessary sales and servicing organisation and, indeed, the time required to manufacture many of the individual items of equipment was such that no early dividend could be expected on our efforts. But, Mr. Wilson said, by the later months of last year there was to be seen a growing volume of engineering exports to Canada and, in the orders that were being placed, the assurance of still further increases. Those who had been concerned with that great development of our dollar exports knew what it had meant in terms of production and sales efforts, how much energy had had to be devoted to building up sales organisations, and how much risk had had to be taken in promotional expenditure and the holding of stocks.

Our industries, Mr. Wilson emphasised, had now firmly established themselves as suppliers to Canada of heavy electrical equipment, machine tools, telecommunications equipment, internal combustion engines, printing machinery, textile machinery and many other items. Television and transport equipment were now being supplied and British manufacturers were known to every major undertaking in every Province of Canada. Already exports of British engineering equipment had doubled over the past two years. It would be unrealistic, however, in the face of the new difficulties which had arisen, to expect that that rate of increase could be indefinitely maintained. But, Mr. Wilson observed, one thing which had clearly emerged from the Convention was that this country must do everything in its power to meet Canada's requirements for capital goods both to assist her defence production and economic development and to develop the market for our products for the years ahead.

Australian Engineering News

Welding in Ship Construction

In the course of a paper presented to the Welding Engineering Symposium, Mr. K. M. Lawson, of Cockatoo Docks and Engineering Pty., Ltd., of Sydney, N.S.W., outlined the methods used in that establishment, which is the largest of its kind in Australia. He pointed out that it was necessary partly to re-equip the shipyard and to set aside a special area for prefabrication of the various units of the hull. That area consisted of a reinforced concrete surface 210ft by 50ft, adjacent to the building berth, on which a major portion of the ship under construction was prefabricated. The general procedure as explained by Mr. Lawson is outlined below.

"Datum points were marked on brass plates inserted in the concrete, from which accurate measurements could be taken. In addition to the portion of the vessel built on this slab, other units were built in available space close to the slipway. Using the present methods of construction, the deck was built in panels, these panels being portions of the various units. The deck panels were fully welded, by machine where possible, complete with beams and girders. They were then set out on the concrete slab and the joining butts of the panels tacked together. They were then positioned in a fore-and-aft line, corresponding to the line of the deck girders. With the deck so close to the base access was obtained to the inner portion by leaving off shell plates, which, however, proved inconvenient, and accordingly the following portions were kept approximately 2ft above the slab to permit access through the holes cut for scuttles in the deck. With this deck as a base, bulkheads were positioned with the keel portion uppermost; then followed deep frames, longitudinals, intermediate frames and the complete keel unit, including vertical and flat plate keel.

"On this framework the shell was positioned and the structure welded into separate units, adjacent to, but not fully connected to, each other. These units were broken up on completion of all welding and repositioned on the building berth where they were finally welded together in strict sequence. Records of the welding sequence for each unit were kept for comparison with those used by other yards, and included details of all weld sizes, plate edge preparation and other reference data. Radiographic examination was freely employed for inspection."

A radiographic laboratory is now being installed at the dockyard and a Universal magnetic crack detector and an ultra-violet crack detector will also be provided.

Murray Valley Development

In the Murray River Valley plans for increasing irrigation and providing an abundant supply of electric power have been put in hand. It is intended to extend the area of electricity supply along the whole length of the Murray Valley to the borders of South Australia involving the building of a 220kV transmission line for 350 miles from the Kiewa hydro-electric stations to Swan Hill. The scheme is estimated to cost £A6½ million and will be spread over fifteen years. The controlling Commission reports that the first stage will include new diesel power stations at Swan Hill and Mildura. The second stage will include the erection of the power line referred to above, which will link those districts with the Commission's main sources of power, the Yallourn brown coal power station, and the Kiewa hydro-electric development. The water from Kiewa will be diverted back to the Murray River and serve to increase the irrigation of the areas to which the electric supply is being extended.

American Engineering News

(From our American Correspondent)

Nuclear Reactors for the Generation of Electric Power

In announcing its decision to co-operate, under certain conditions, with industrial concerns intending to explore the field of power-generating atomic piles, the Atomic Energy Commission has taken an important step towards the development of this aspect of nuclear reactors. Two industrial groups, the Monsanto Chemical Company and the Detroit Edison Company, in conjunction with the Dow Chemical Company, have approached the Commission, outlining their plans for building reactors for the production of plutonium, the resulting heat to be employed in the generation of electric power. The companies concerned have requested that the Government should supply the uranium necessary for such development work, with the understanding that any plutonium produced as a result of experiments would be turned over to the Government. It is understood that the industrial concerns involved would take part in this project on their own initiative and using their own resources. The Monsanto Chemical Company is already gathering a staff in order to launch an initial investigation of the feasibility of applying atomic energy to the production of electric power for use in its particular industry. The company visualises construction of a power plant with a capacity ranging from 50MW to 100MW, to be built at an estimated cost of between 25,000,000 and 40,000,000 dollars. It is intended to use any power so generated in the production of such chemicals as phosphorus, chlorine and calcium carbide. These operations, to a large extent, are being planned to take place in parts of the United States that are, at present, short of electric power.

Operational Trials of 4500 h.p. Gas Turbine-Electric Locomotive

A further report has become available dealing with the operational trial runs of the General Electric Company's 4500 h.p. gas turbine-electric locomotive. It will be recalled that the locomotive is geared for a speed of 69 m.p.h. and has an average weight of 225 tons. It has a single-shaft power plant, operating on a simple cycle without regenerators. The control of the power plant, and of the locomotive, is basically the same as that used on diesel-electric locomotives. Since the issue of an earlier report last year, the locomotive has operated over 68,000 miles and has worked 242,389,000 ton-miles. The total mileage is more than 85,000. The locomotive has been in service between Los Angeles, California, and Salt Lake City, Utah; between Ogden, Utah, and Cheyenne, Wyoming; and between Cheyenne and Council Bluffs, Iowa. These places are at elevations from sea level to 8014ft and ambient temperatures from 117 deg. to −8 deg. Fah. The service has been average freight service in this region, except for the fact that practically no local freight trains were handled. The tonnages involved were in accordance with the ability of the locomotive to manipulate long, sustained grades. On short grades 4000 tons have been handled successfully on 1·25 per cent grades and 6000 tons on 0·7 per cent grades. Considering "availability" as the percentage of total time in which no mechanics are working on the locomotive, the overall availability since August, 1949, has been 39·7 per cent. This figure includes major periods spent in the shops, during which design changes were made and developmental troubles were corrected. Since these periods cannot be classified as heavy maintenance, the corresponding availability figure, not accounting for them, would be approximately 58 per cent. For a period of two months, availability approached 80 per cent. Operating cost figures, after eighteen months of tests, still have relatively little meaning. A great deal of the operation has been on special fuels for special test purposes. Furthermore, no heavy maintenance has been performed. The locomotive is still using its original wheels, although they are approaching their first turning. Taking operating costs as compiled, adding an estimated amount for heavy maintenance, and comparing the result with an average of diesel-electric locomotive operational costs, there is an indication that operating costs of gas turbine-electric locomotives may compare favourably with diesel-electric locomotives. From the train-handling point of view, the performance of the locomotive continues to be satisfactory. It has been able to start its tonnage under all the operating conditions encountered. Adhesion characteristics have been good and the power output has continued to be above the original estimates. Progress has been made in correcting the design details, which were responsible for the early troubles. There has been a marked improvement in combustion chamber life and fuel handling and cleaning have become satisfactory operations. Electrical troubles have continued to be negligible. The starting of the power plant has become a routine operation and tunnel working has continued to be quite satisfactory. The locomotive operated through the Aspen tunnel without difficulty, although some trouble was experienced at Hermosa with a 50 m.p.h. trailing wind. This trouble was due primarily to the fact that operating instructions were not being followed. A considerable amount of further testing is still required with regard to suitable fuels, cold weather operation and operation under heavy snow conditions.

Production of Turbo-Generators

The General Electric Company, of Schenectady, New York, broke its record for the production of large turbo-generators last year. During its first full year of operation, the company's new turbine shop turned out units with a combined capacity of 2866MW. Practically all of these units were supplied to power companies in the United States. It is reported that the trend in 1950 was toward higher temperatures and pressures. Almost three-quarters of the machinery produced in 1950 was built to operate at temperatures of 900 deg. Fah. or higher, with 25 per cent being in the 951 deg. to 1050 deg. Fah. range. More than half of the units were built for pressures in excess of 1251 lb per square inch and 27 per cent were in the 1450 lb to 2000 lb per square inch range. Altogether, steam turbo-generators built during the last year ranged in size from 15MW to 165MW. The average rating of these units was approximately 55MW, showing an increase of more than 12MW over the average rating of turbo-generators built and supplied only two years ago.

The Pennsylvania Railroad Accident

About half of all the passengers carried by the American railways are "commuters," or suburban travellers. The biggest commuter city is, of course, New York, where, on a typical business day, some 500,000 persons move by train into lower Manhattan and the commercial parts of Brooklyn from Long Island, Connecticut, Westchester County and New Jersey. The year 1950 was one of unprecedented tragedy for suburban travellers in New York. Last February, at Rockville Centre, two Long Island Railroad trains crashed head-on and killed thirty-two persons. Last November, at Richmond Hill, one Long Island Railroad train crashed into the rear of another and killed seventy-nine. In both disasters, "human failure" was at least partly to blame; drivers either ignored or failed to see danger signals. But part of the blame was also attributed to the difficulties of the Long Island Railroad, which is trying to cope with increasing passenger loads while in a low financial state and operating obsolete equipment.

On February 7th there was another disaster, this time in New Jersey, and on one of America's wealthiest railways, the Pennsylvania Railroad. A wreck at Woodbridge killed eighty-three persons and injured hundreds. It was the worst railway wreck in the United States since 101 persons were killed at Nashville, Tennessee, in 1918. At 5.10 p.m. a suburban train, called "The Broker," left Jersey City with about 1000 passengers bound for a number of suburbs situated along the New Jersey shore of the Atlantic Ocean. After a stop at Newark, the train headed south across the flatlands for the town of Perth Amboy. Near the end of this particular stretch is the town of Woodbridge, where a spur of temporary track, curving rather sharply over a trestle of heavy timber, had been put into operation earlier in the day to permit certain highway construction in the vicinity. Drivers had been warned to slow down to 25 m.p.h. over the curving spur. Before "The Broker," several trains passed over the trestle without incident. According to the driver, the train approached Woodbridge at the rate of 60 m.p.h. Watching for the curved spur, which carried no warning signal lights, he slowed down to 50 m.p.h., when, at 5.43 p.m., the locomotive entered the curve and traversed the trestle. Suddenly, in the words of the driver, the locomotive "bucked and reared like a horse," and was flung on its side. The tender and five carriages were thrown down an embankment. Most of the passengers killed were in the third and fourth coaches, which crushed one another.

Production of Emergency Tinplate

As a result of recently introduced Government controls, the American tinplate industry has been cut back 20 per cent in the use of tin for the first quarter of 1951 and 30 per cent for the second quarter. It is, therefore, of interest to note that the Weirton Steel Company, of Weirton, West Virginia, has introduced a tinplating process, which makes possible tin savings amounting to 25 to 50 per cent. In accordance with this new method, electrolytic tinplate is plated on one side with the amount of tin coating necessary to protect the contents of the eventual tinplate container, but on the other side with only the amount of tin coating required to protect the outside of the container from exposure. This is believed to be the first time that tinplate has been produced in the United States with unequal coating thicknesses on the two sides.

A Powerful Turbo-Jet Engine

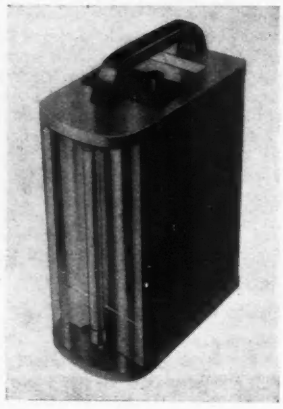
The U.S. Navy has released certain details relating to its latest turbo-jet engine, the "J-40," which is scheduled for early quantity production. The engine was designed and built by the Westinghouse Electric Corporation and is claimed to be more powerful than the Armstrong Siddeley "Sapphire," which had previously been considered the most powerful jet-turbine. The "J-40" develops a thrust of 10,000 lb, compared with the 3000 lb thrust of the "J-34," which is generally being regarded as its predecessor. The engine weighs less than 3000 lb and has a power rating of 14,000 h.p. at "moderate flight speeds" (about 600 m.p.h.).

A Coating Thickness Gauge

Apparatus which employs a Geiger counter for measuring the thickness of tin, paint and other kinds of protective coatings on steel, has been introduced by the North American Philips Company, of Mt. Vernon, New York. The gauge employs X-ray and Geiger counter tubes above and below the sheet being tested, so that coatings on both sides can be measured simultaneously. The sheet to be tested is passed through an opening between the counter tube supports. The X-rays pass through the coating, strike the base metal and are reflected back through the coating to the Geiger counter. The higher the reading on the counter the thinner is the coating. It is stated that, by means of the gauge, individual spot checks can be performed on average coated sheets in twenty seconds and thirty seconds per test. Readings may be either visual or recorded on tape. The apparatus may also be adapted to measure coatings on continuous strip. According to the manufacturers, coating thicknesses from 10 to 120 micro-inches can be measured within an accuracy of 2 per cent. A gauge which is able to accommodate steel sheets up to 39in wide is now in use at the Irvin Tinplate Works of the United States Steel Corporation.

Portable Fluorescent Hand Lamps

A USEFUL range of portable fluorescent lighting equipments or hand lamps has been introduced by Process Control Gear, Ltd., St. Albans, Herts. Our illustration shows the general appearance of the hand lamp, which, in its sheet-steel casing, measures 7¾in by 4½in by 12in high. The light source



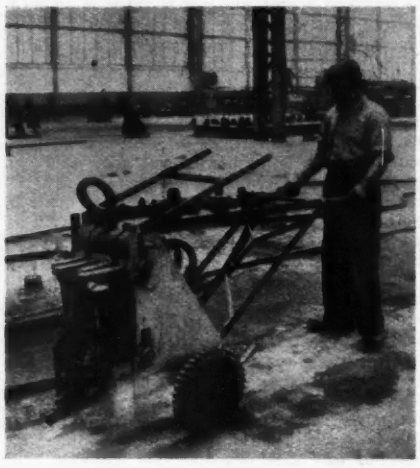
"PROSCON" FLUORESCENT HAND LAMP

is a 6W fluorescent tube, which has an estimated working life of about 1000 hours, the reflector being designed to provide good illumination over an angle of 180 deg. A window of transparent plastic material protects the tube and reflector.

There are three different versions of the hand lamp in production. The first, known as model "B1," is battery-operated and is designed to house two 45V "Drydex H1156" batteries connected in series. With its batteries, this lamp has a total weight of 8¼ lb. Another form of lamp, the model "P1," is outwardly similar to the battery-operated equipment, but the batteries are replaced by the necessary chokes and starting device for direct use on a 200V-250V, 50 c/s supply, a four-yard length of three-core flexible cable being supplied as standard. In this form the complete hand lamp weighs 4¾ lb and constitutes a useful inspection lamp, particularly in workshops and garages. The third form of hand lamp, known as model "U.1," is capable of being operated from batteries or mains. It is supplied complete with its batteries, flexible lead and the necessary resistances and chokes. Besides the usual starter buttons, there is a selector switch housed in the top cover, to allow the lamp to be switched for battery or mains operation as required. Collapsible hooks are provided for winding up the mains lead when not in use. The all-up weight is 10¼ lb.

A Highway Surfacing Machine

AN interesting machine which is intended for roughening granite sett or concrete surfaces of roads to increase their resistance to skidding, has been produced by the Metropolitan Construction Company, Ltd., 66, Queen Street, London, E.C.4. The machine is very simple in its construction, and as developed at present consists essentially of four rotary pneumatic drills fixed rigidly together and mounted vertically on a light steel framework, with provision for adjustment. The framework is carried on a pair of 14in rubber-tyred wheels, on which the machine is almost equally balanced, thereby enabling the operator to control with ease the action of the drills on the surface which is being roughened. A cylindrical compressed air reservoir is fixed across the top of the machine from which four lengths of hose lead to the drills. The reservoir is fed from a single hose from the compressor. The pipe to which this hose is fixed is attached to one of the handles of the machine, and incorporates the control lever. Guides are provided near the bottom of the shanks of the drills. These details may be seen from the illustration reproduced herewith, which shows a machine mounting two drills. The drills can be mounted in a single line, or staggered slightly to facilitate



SURFACING MACHINE IN OPERATION

the weaving motion described below, and shields can be fitted round the drills to reduce flying grit as much as possible.

By slowly pushing the machine forward and simultaneously imparting a weaving action, the operator ensures that the drills cover the whole of the area underneath it, thus preparing a strip of approximately 24in width. The fineness of the finish can be varied by the type of bit used. Generally about $\frac{1}{16}$in to $\frac{1}{8}$in is taken off the surface in very small chippings. The rate of working averages about 100 square feet a day.

The machines were first used to treat concrete highway surfaces, but experiments were later carried out in Glasgow in treating nidged granite setts. The treated setts were tested by the Road Research Laboratory, and a preliminary report by that body indicated that the sideways force coefficient was increased to a value of about 0·65–0·70, from a value of 0·35–0·40, for the untreated setts, thus reducing the stopping distance for a speed of 30 m.p.h. from about 73ft to about 43ft. Furthermore, it was thought that the sideways force coefficient for the untreated setts was probably increased by grit washed from the treated portion, so that a value of 0·25 was probably a better indication of their original condition.

The machines are at present being used to roughen the granite sett surface of Lea Bridge Road for the Hackney Borough Council, in London. Apart from such applications to highway surfacing, however, they can also be used for roughening concrete floors to give a good key, and it is thought that a useful application will be in the preparation of sub-floors for the laying of the top dressing. The machine shown in our illustration is engaged on this class of work.

BRITISH SCIENTIFIC INSTRUMENTS EXHIBITION IN PARIS.—At the invitation of the French government, the British Council is organising an exhibition of British scientific instruments, to be held from May 11 to 17, 1951, at the Sorbonne, in Paris, simultaneously with the annual French Physical Society Exhibition.

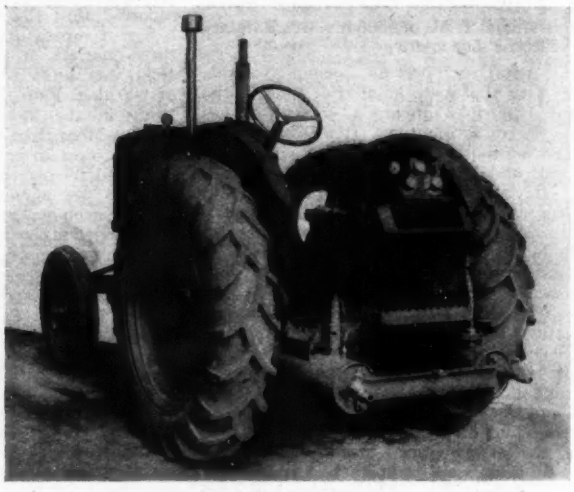
A Mobile Air Compressor Unit

THE range of mobile air compressor sets made by Holman Brothers, Ltd., Camborne, Cornwall, has been extended by the introduction of an improved model of the firm's "Tractair" unit. This unit, to be seen in the photograph reproduced on this page, consists of a standard wheeled tractor having a two-stage compressor mounted on the rear of its frame.

The compressor is attached to a rigid cross member of the tractor frame by anti-vibration mountings and is driven through vee-belts from the power take-off pulley. The Fordson tractor to which the unit is adapted can be fitted with a petrol or a Perkins diesel engine developing 30 h.p. at 75 per cent full load at 1440 r.p.m.

The single-cylinder, two-stage compressor has bores of 7½in and 5½in by 4½in stroke, and is driven at 1200 r.p.m. With a displacement of 130 cubic feet a minute at 125 lb per square inch it is capable of operating at full pressure two heavy road rippers, a heavy-duty rock drill or equivalent equipment. Air is drawn into the compressor through a large filter fitted in an accessible position over the unit and an intercooler is mounted on the rear of the unit. Air is fed into the tool lines from two large receivers set on each side of the tractor frame beneath the compressor, and standard couplings for the air lines are provided at the ends of the receivers. An air-operated governor fitted to the engine controls the engine speed, and, thus, the fuel consumption, in proportion to the volume of compressed air required for the tools.

The makers point out that with the compressor unit fitted a tractor has a road speed of 15 m.p.h., and the drawbar remains available



TRACTOR-MOUNTED COMPRESSOR

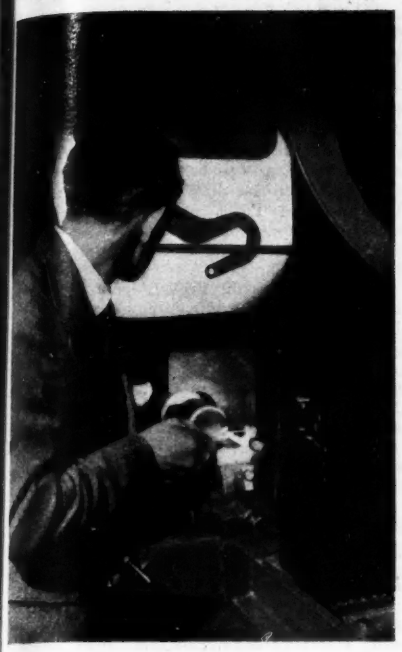
for towing purposes. When fitted with pneumatic tyres as illustrated the unit has a ground clearance of 1ft 2in and, if required, steel wheels with spuds can be supplied.

A Workshop Projector

A SPECIAL works projector has been developed by Optical Measuring Tools, Ltd., of Slough, Bucks, to permit final finishing work to be carried out on templates, profile gauges, &c., whilst they are being optically projected for comparison with an enlarged drawing. With this machine in use a tool maker can file or stone his workpiece in the inspection position and not have constantly to move between his work bench and the projector as is the general practice.

The projector, which is illustrated opposite, is fitted with two vices for work-holding purposes, one vice being set under the optical axis of the projector so that the magnified image of the work appears on the screen. Work in

this vice can be filed or stoned to the finished profile, as shown in our second illustration, without being removed from the optical system. Where coarse filing is necessary to remove high spots the work is set in the second



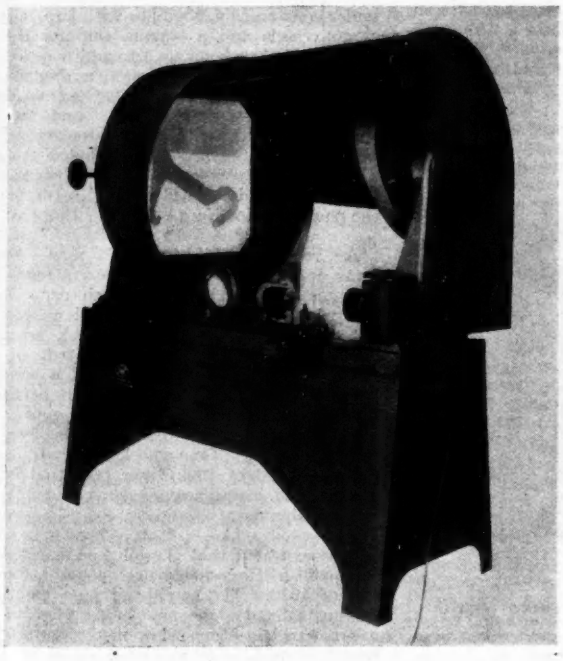
PROJECTOR IN USE

vice, where all its contours are more easily accessible.

The projector is mounted on a rigid, fabricated steel-section base and bed, which contain drawers for spare equipment storage. Lighting is provided by a 250W high pressure mercury vapour lamp, used in conjunction with a condensing lens system. Normally two sets of lenses are provided—one of 4½in and the other of 9in focal length, the respective fields of view covered being 1·45 and 2·9 square inches. These lenses give nominal magnifications of 10× and 20× and the magnification can be varied in small increments from 19× to 20× and 9× to 10×. Magnification scales are mounted on the instrument bed, to indicate the precise magnification. This variable magnification makes it possible to compensate for known metal contraction when making die or template parts.

To keep the length of the instrument to reasonably small limits, the image is reflected on the screen through two tilted mirrors and this arrangement has an added advantage in that the workpiece, when in either of the vices, is in close proximity to the image on the screen.

Metal insets are fitted to the vertically mounted wooden screen to facilitate the mounting of master drawings, either by pinning or attachment to the insets. The 30in square screen can be moved angularly, vertically or horizontally to facilitate alignment of a drawing with the work image, and it is shrouded by a metal hood and a curtain so that the instrument can be used under normal lighting conditions in a shop.



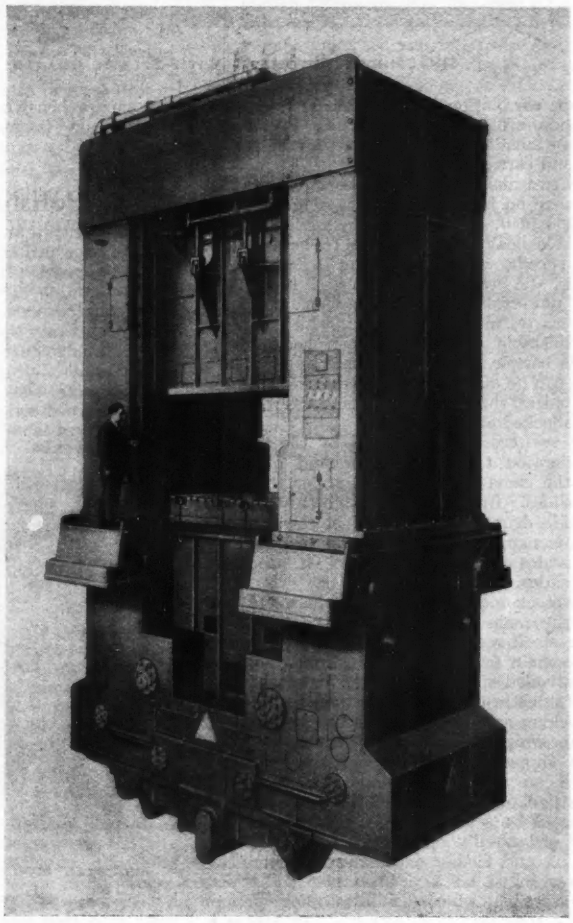
WORKSHOP PROJECTOR

Improved Clearing Press

DETAILS have been issued of a recent development in the design of the double-action presses made by the Clearing Company of Chicago, and manufactured in this country by Vickers-Armstrongs, Ltd., for distribution by the Rockwell Machine Tool Company, Ltd., Edgware Road, London, N.W.2. One of the new presses, which have been given the trade name "Hiprodraw," is illustrated on this page.

A new linkage system embodied in the press reduces the cycle time required to produce a drawn blank without accelerating the drawing operation. With the improved arrangement the inner slide of the press approaches the work at the same high speed as the blankholder slide, and when the blankholder slide gets to its dwell position the inner slide carries on to complete the drawing stroke at a reduced speed. When the drawing operation is completed both the slides retract to their top position at high speed. It is claimed by the designers that the introduction of the improved slide linkage makes it possible to operate the press at a cycle speed 70 per cent faster than that of a conventional double-action press. It is also pointed out that when the machine is operated at the same cycle speed as conventional double-acting presses, scrap losses through faulty material are reduced as the drawing speed is so much slower. Maintaining the same cycle time as a conventional press, the "Hiprodraw" press can have a drawing speed 40 to 50 per cent slower.

Two classes of press are being made, one with a top drive and the other with a bottom drive, and in each a single drive for both slides is used. As can be seen in our illustration the entire drive of a bottom drive machine is housed in the bed below floor level.



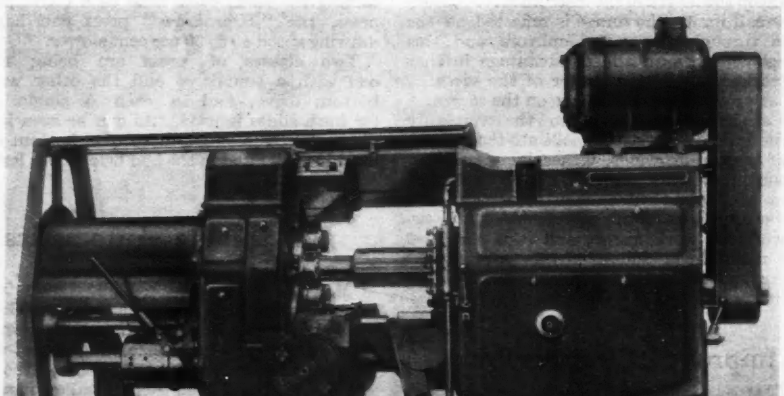
IMPROVED DOUBLE-ACTION PRESS

Six-Spindle Automatics

WE are informed by B.S.A. Tools, Ltd., of Marston Green, Birmingham, that it is now manufacturing under licence Acme-Gridley six-spindle automatics of 1in, 1¼in, 1⅝in and 2⅜in capacities. These machines, one of which we illustrate overleaf, are in addition to the four-spindle 2¼in and 3½in Acme-Gridley machines already being manufactured at the B.S.A. works.

The frames of the machines are built up from four main castings—pan, headstock, gearbox and top rail—and all the mechanisms are totally enclosed to prevent the ingress of dirt and swarf. The tool slide, of heat-treated high-carbon steel, which is fitted with renewable bronze bushings and a front wiper, has a positive stop to control the depth of drilling, reaming, length of turning, &c. The tool slide guide is mounted on a bracket underneath the slide so that the third, fourth and fifth positions are left free for the independent operation of threading, accelerated drilling or reaming attachments. To ensure alignment

of tool-holders and spindle in manufacture, the holders are mounted on the slide before being bored out from the spindle and permanent correlation is ensured by mounting the slide around a stem, which is integral with the spindle carrier, and then grinding both stem and carrier at one setting.



SIX SPINDLE AUTOMATIC WITH SPLASH GUARDS REMOVED

The two main cross-slides are wide and long and move on hardened steel ways mounted on the headstock. This firm mounting is intended to enable heavy forming cuts to be taken at high speeds without causing vibration or chatter. A cam drum beneath each slide gives powerful and direct action and each slide has an independent stop, which engages an adjustable stop on the periphery of the spindle carrier. Small adjustments for depth of cut can be made without interfering with the tool-holders, through an adjusting screw, which can be locked after setting.

The two cross slides carried by the top rail are operated through a lever and quadrant from the cams on the drums under the main cross slides. In the 2¼in machine only the two top slide drums are mounted in the top rail. The arrangement of the stops for the top cross slides is similar to those on the main cross slides.

The stock reel is driven by a shaft and gear from the main spindle carrier, the front disc of the stock reel rotating in a guide mounted on the main frame. Each stock tube is lined with a coiled spring, which prevents whipping of bar stock in the tube and eliminates noise.

Chucking and feeding slides are mounted on long bearings on two large diameter steel shafts, supported in the headstock at one end and in an arch support at the other end. Prevention of chuck release during machining is effected by a guard, which ensures that the spools will not fly open. Cams for operating chucking and feeding mechanism are conveniently arranged on a drum under the slides, an arrangement which facilitates quick changes and the removal of end stock. Restocking is done by the use of a manual chucking shoe, which is in the first position.

The machine is driven through vee belts from a motor mounted on an adjustable platform over the headstock. Pick-off gears, which are used to effect speed and feed changes, are situated at the drive end of the machine and are readily accessible without disturbing the motor drive. Change from approach traverse to cutting traverse speeds is effected through cone and plate-type clutches, which actuate a cam and work in conjunction with a brake.

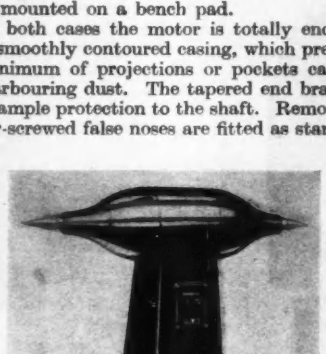
A modified Geneva mechanism is used to index the spindle carrier from a standstill, rapidly accelerating, then decelerating, and finally bringing the carrier to the stopped position before the locking bolt slides into place.

A comprehensive range of tool-holders and attachments is available for each size of machine.

Polishing Motors

Our illustration shows a polishing motor arranged for pedestal mounting, designed and manufactured by Higgs Motors, Ltd., Witton, Birmingham, 6. The same motor is also available mounted on a bench pad.

In both cases the motor is totally enclosed in a smoothly contoured casing, which presents a minimum of projections or pockets capable of harbouring dust. The tapered end brackets give ample protection to the shaft. Removable taper-screwed false noses are fitted as standard but, if required, parallel screwed ends, complete with clamp plates and nuts, can be supplied as an extra.



PEDESTAL MOUNTED POLISHING MOTOR

The motors are squirrel-cage machines, wound for 200V–500V two or three-phase, 50 or 60 c/s. There are two capacities available, with rated outputs of 2 and 5 b.h.p., respectively, the nominal full load speeds in each case being either 2800 r.p.m. or 1430 r.p.m., at 50 c/s, and 3400 r.p.m. or 1720 r.p.m. at 60 c/s. In both bench mounting and pedestal forms the three-phase machines incorporate a built-in push-button direct switching starter, the associated wiring being totally enclosed. With two-phase supplies, however, the manufacturers may supply the starter as a separate unit.

French Engineering News

(From our French Correspondent.)

The completion of several important works in the Gaz de France equipment programme took place in 1950. This programme, which forms a part of the Monnet Plan, is intended to concentrate production in coking plants or gas plants with high output, and to improve collection, transport and distribution. The steel pipe-line transporting high-pressure gas (40kg per square centimetre) between Sarreguemines and Nancy, was completed, enabling gas-works at Nancy, Baccarat, Luneville, Saint-Die and Raon-l'Etape to be closed. This pipe-line forms part of the proposed gas main to link Lorraine and Paris. Gas producing plants were completed at Strasbourg and at Vierzon. The latter plant will shortly supply Vierzon, Bourges and Nevers.

The capacity of French gas plants was increased by 1,500,000 cubic metres daily in 1950; 400km of high-pressure mains were installed and 900km of distribution piping; 90,000 new subscribers were supplied and twenty obsolescent gas plants were replaced. New plants are under construction at Saint-Denis, Alfortville, Rouen and Gennevilliers (Paris). However, the original five-year plan is well behind schedule, and by the end of December, 1950, it had been 25 per cent completed, instead of 50 per cent, as originally contemplated.

* * *

Activities of the Ateliers et Chantiers de Bretagne in the course of 1950 included the completion of two mixed cargo vessels, the 3000-ton "Sidi-Ferrech" and the "Azemmour." The suction dredger "Paul Solente," intended for dredging the approach channel of Port Said, and the dredger "Fatouville," for the port of Rouen, were completed and the company's shipyards also manufactured diesel engines for the vessels "Dunkerquois" and "Brestois."

At present three 3500-ton cargo vessels are under construction, together with two 1650-ton cargo vessels and a banana ship for the Cie. Générale Transatlantique. In addition, the port of Rouen has ordered a suction dredger, the "Charles-Belleville"; the Cie. Générale Transatlantique, a 1200 h.p. tug; and the Cie. Nationale du Rhone, a bucket dredger. Other work at the shipyards has included the construction of two turbines for the packets "Flandre" and "Antilles," and a turbine for the packet "Viet-Nam."

* * *

A recent exhibition of new French arms constructed under the rearmament programme included artillery such as a 75mm gun which weighed 70 kilos, and was carried on a 20 kilo tripod. Anti-tank weapons, effective at 600m, were also exhibited.

The Panhard company showed a series of armoured vehicles, one of which carried a "tower" mounting three machine-guns. This armoured car is equipped with a 200 h.p. engine and has a four-wheel drive. It has an average speed of 100km per hour and is also designed to carry heavier guns and anti-aircraft equipment.

* * *

It is expected that the oil pipe-line between Paris and Le Havre will be completed before the end of 1952. The completed pipe-line will be 300km in length, the pipe being 25cm in diametre, and laid 80cm below the ground surface. It will be used for transporting a variety of oils including heavy oil, gas oil and petrol, its annual capacity being 1,500,000 tons. Five refineries situated on the Seine will be served, and at the approach to Paris, after the Colombes aqueduct, the pipe-line will divide into two branches, serving twenty-two storage reservoirs. One branch of the pipe-line will go towards Nanterre and serve aerodromes in the Versailles region, and the other towards Saint-Ouen. A central pumping station will control the distribution. The pipe-line is being built by the Sté. des Transports Petroliers par Pipe-Line, a company in which the State is the main shareholder, and it is estimated that it will cost about three milliard francs.

Industrial and Labour Notes

The F.B.I. and the Budget

At the end of last week the Federation of British Industries issued a memorandum setting out representations which it has made to the Chancellor of the Exchequer about the forthcoming Budget. It recalls that, in recent years, the Chancellor's attention has been directed consistently to the grave and urgent problems which arise as a result of the lack of capital needed by industry to replace or modernise fixed assets, maintain stocks and to keep up production. The root cause of this shortage of capital, the F.B.I. points out, is the severe rate of taxation imposed during the last decade, aggravated by the method of computing profits for tax purposes.

The Federation has examined the present taxation position as it affects industry and is of the opinion that, to meet the financial needs of the defence programme, additional taxation is not inevitable. No additional burden can be placed upon industry, it says, if serious prejudice to the ability of industry to maintain production in the country is not to ensue. The F.B.I. view is that the Government's budgetary policy should be to preserve industrial capital in the face of inflationary pressure; to remove discriminatory taxation on corporate bodies and to spread direct tax more widely over the general body of taxpayers; to counter inflationary pressure by drawing off surplus purchasing power where it lies; to avoid any increase in the total burden of taxation and to find the major part of the finance for rearmament by reductions in other forms of Government expenditure, and to readjust the incidence of taxation so that it does not constitute a deterrent to greater effort, in particular by industry.

On this last point, the F.B.I. recommends that there should be immediate review and adjustment of the present incidence of taxation. It urges that reserves for depreciation of fixed assets on replacement costs, and for replacement of stocks at higher prices, should be tax-free, and that the profits tax should be withdrawn. It also suggests that a shift of the burden of taxation from production to consumption should be sought—that is, that any additional indirect taxation which is necessary should be imposed preferably on those forms of consumption which it is most desirable to restrict.

The T.U.C. General Council

The monthly meeting of the General Council of the Trades Union Congress was held in London on Wednesday of last week. Following its usual practice at this time of year, the Council decided to submit to the Chancellor of the Exchequer suggestions related to the Budget. In a statement issued after its meeting, the Council said that it appreciated that a considerable overall increase in taxation would be necessary, but it did not think that that should rule out the possibility of concessions, particularly those calculated to stimulate production and to help people with lower incomes.

The proposals advanced by the General Council include an increase in the standard rate of income tax, together with an adjustment of reduced rates to lessen the "disincentive" effect of large increases as between the reduced rates and the flat rate. It was also agreed to suggest a moderate raising of the income tax exemption limit to help people on very low incomes. The rate of profits tax, the Council considered, on both distributed and undistributed profits should be increased, and a further recommendation was that subsidies should be increased "as far as practicable, having regard to other financial commitments, in order to reduce the effect of rising import prices on the cost of living." Wherever possible, the General Council added, the Government should absorb increased expenditures by administrative economies.

But as well as discussing suggestions for the Budget, the T.U.C. General Council considered and approved some proposals related to the system of conciliation and arbitration in industrial disputes. A proposal which was endorsed by the Council involves the revocation of the existing compulsory arbitration Order 1305, and its substitution by an Order designed to encourage resort to arbitration as a means of avoiding strikes and lock-outs, but containing no clause prohibiting them. Another matter before the Council concerned the employment of elderly workers. In view of the present labour shortage, the Council reaffirmed its support of the removal of restrictions on the employment of elderly workers, and suggested that appropriate negotiating bodies should examine the problem of fixed retirement ages.

European Steel Trends

The United Nations Economic Commission for Europe has published this week some additional information connected with its study of European steel trends. It revises to some extent the study which was made by the Commission at the end of 1949. The Commission now suggests that, on the basis of present plans, Europe—excluding the U.S.S.R.—may expect by 1953 to have capacity for the production of nearly 75,000,000 tons of crude steel. Actual production last year, the report says, was 60,700,000 tons. This production forecast assumes the complete fulfilment of existing plans, but forecasts of consumption which are made in the report do not take account of enlarged defence programmes. Certainly, the importance of those programmes is stressed, but the Commission does not think it possible at present to determine their future direct and indirect effects.

The report proposes the reduction of European steel costs by rationalising production, ensuring adequate supplies of good quality and cheap raw materials for steel-making, and by a wide exchange of information on improvements in steel-producing techniques. Other measures suggested by the Commission are the promotion of knowledge of steel uses and the development of new uses for steel, the maximum possible freedom of trade in steel, and such a degree of restraint on steel prices as would permit the benefits of low cost production to be fully realised.

The Commission says that new plans envisage capacity for an annual production of 63,200,000 tons of steel in Western Europe in 1953, which is 3,400,000 tons more than was estimated in 1949. Production capacity plans for Eastern Europe (excluding the U.S.S.R.) have been increased 1,000,000 tons for a 1953 total of 11,500,000 tons. There are indications, the report states, that the European planned total of nearly 75,000,000 tons of crude steel capacity will be reached by 1953, and that production itself might attain that level, "provided adequate supplies of raw materials are available and the demand for that quantity of steel exists."

Engineering Wages

It will be recalled that the agreement on wages made last November between the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions provided for increases of up to 11s. a week for skilled time workers and of up to 8s. a week for unskilled workers, bringing their weekly remuneration up to £6 8s. 2d. and £5 6s. respectively. Provision was also made for adjustment of piecework prices or times so that pieceworkers might be able to earn at least 45 per cent on the existing basic time rates instead of 27½ per cent as formerly.

In recent weeks, however, there have been disputes in various engineering establishments—mainly in the North—as some pieceworkers have claimed that they should receive, in addition, the 11s. or 8s. "differential." These disputes have led to men imposing a ban on piecework and on overtime which, of course, has seriously affected production in the establishments concerned. By the end of last week one or two works in the London area became involved in the disputes, and in some cases men who have refused piecework have been given notice of dismissal. The action taken by the men is quite unofficial, but on Monday last leaders of the Confederation of Shipbuilding and Engineering Unions discussed the disputes with officials of the Ministry of Labour. It was then expected that talks on the whole matter might take place later in the week between the Confederation and the Engineering and Allied Employers' National Federation.

Railway Shopmen's Wages

When the recent railway wages agreement was reached, it did not include those employed in railway workshops, numbering about 120,000, on whose behalf a claim for a "substantial increase" in wages was put forward some months ago. The Railway Executive's reply was an offer of increases ranging from 5s. a week for the lower grades to 7s. a week for skilled craftsmen. At a meeting of the Railway Shopmen's National Council last week, that offer was rejected by the unions. At the end of last week it was reported that the Railway Executive had made a new offer suggesting increases ranging from 8s. 6d. to 10s. a week, the cost of which to the Executive would be in the neighbourhood of £3,000,000 a year. At a further meeting of the Railway Shopmen's National Council on Tuesday last, agreement was reached on this offer.

Index of Industrial Production

The Index of Industrial Production, which is prepared by the Central Statistical Office (1946=100), was 138 for all industries in the month of December last, or 13 points lower than the figure for November. The December figure was naturally affected by the Christmas holidays. Details of the index figure for individual industries have not yet been worked out, but for the manufacturing industries as a whole the December figure was 141, compared with 157 in the months of October and November, and with 132 in the fourth quarter of 1949.

The Coal Situation

The Ministry of Fuel and Power states that production of deep-mined coal last week amounted to 4,369,300 tons, which was 36,600 tons below the amount raised in the preceding week, but about 250,000 tons more than in the corresponding week of last year. Production of opencast coal improved last week, owing to better weather, and amounted to 211,500 tons, which brought the total coal output for the week to 4,580,800 tons. In the first nine weeks of this year 39,494,300 tons were gained, compared with 38,659,500 tons in the corresponding weeks of 1950. Coal imports last week amounted to 58,700 tons.

In the week ended February 24th, the number of men on colliery books was 700,100, which was exactly 1000 more than in the preceding week, and which indicates that the increase in manpower since the middle of November last now amounts to nearly 14,000. Of the number on colliery books in the week ended February 24th, 287,100 were working at the face, the output per manshift at the face being 3·20 tons. Voluntary absenteeism among all workers, at 5·23 per cent, showed little change from preceding weeks, but the figure for involuntary absenteeism, 6·87 per cent, was lower.

Inland coal consumption in the week ended February 24th amounted to 4,473,000 tons, and exports and bunkers took 176,000 tons, bringing the total consumption for the week to 4,649,000 tons, compared with 4,716,000 tons in the corresponding week of last year. Distributed stocks of coal on February 24th, were 9,786,000 tons, or 71,000 tons lower than in the preceding week.

Notes and Memoranda

Rail and Road

ROAD ACCIDENTS IN 1950.—The Ministry of Transport has issued details of road accidents in 1950. During the year 201,325 persons were killed or injured in 166,592 road accidents, the number of casualties being the highest in any year since the war, and 14 per cent more than in 1949. It is considered that the increase was largely due to the abolition of petrol rationing, and the greater number of motor vehicles on the road. The greatest proportionate increase was among motor-cyclists and their passengers, being 41 per cent more than in 1949, but the number of child deaths (868) was the lowest for more than twenty-seven years. The numbers of road deaths in the years 1938, 1949 and 1950 are given as 6648, 4773 and 5012 respectively.

RECONSTRUCTION OF NITHSDALE ROAD BRIDGE, GLASGOW.—A difficult piece of work was completed in Glasgow towards the end of last year, involving the strengthening of the Nithsdale road bridge over the Cathcart district railway near Pollokshields (West) Station, Glasgow. Reconstruction had been delayed by the war, and the old structure had deteriorated considerably; the work consisted of removing the old steelwork, taking down the old wall or abutment for a length of 380ft, and rebuilding it in concrete with a sandstone facing. A new steel and concrete superstructure was then erected to carry the roadway which was regraded to a new level. The work was done in 12ft lengths, and as it progressed the thick stratum of stiff blue clay to which the formation was excavated started to dip, and after an excavation depth of 11ft was reached, a piled construction was adopted, using 14in by 14in by 20ft long reinforced concrete piles at 5ft centres. The length of abutment so constructed was 140ft. Constructional difficulties were largely due to the congested nature of the site, the services carried by the bridge apart from vehicular traffic with trams and buses, including G.P.O. cables (about 4000 tons), a 12in diameter high-pressure water main, two high-pressure gas mains (one 18in and one 10in diameter), and eight B.E.A. cables, of which three carried 20kV to neighbouring shipyards and engineering works. These utility services were resited without inconvenience to the users. The contractors employed by the Railway Executive for the work were Murdoch Mackenzie, Ltd., the steel subcontractors being P. and W. McLellan, Ltd.

Air and Water

TROOPSHIP COMPLETES REFIT.—The "Dunera," which forms part of the British India Steam Navigation Company's fleet, was specially built as a troopship and has just completed an extensive refit to bring her into line with her sister ship, "Dilwara." Barclay, Curle and Co., Ltd., the builders of the vessel, undertook the work and the ship will now carry 125 first-class, ninety-six second-class and 100 third-class passengers and 705 troops in standee berths.

CRANHILL WATER TOWER.—Glasgow Corporation Water Department recently accepted a contract for the construction of a further reinforced concrete water tower of 500,000 gallons capacity at Cranhill on the eastern outskirts of the city. The estimated cost of the structure, exclusive of mains and pumping station, is £43,000. The tower will be of unusual design, the water retaining portion being square and supported on sixteen circular columns, with a central square access tower. The total height of the structure is 96ft, the floor of the tower being 65ft above ground level. Access to the top of the structure will be by electric hoist capable of carrying up to four people. The joint engineers for the tower are Mr. Stanley D. Canvin, M.I.C.E., general manager of the Water Department, and Messrs. F. A. Macdonald and Partners, consulting engineers. Drummond Lithgow and Co., Ltd., are the contractors.

Miscellanea

THE FEDERATION OF CONSTRUCTION MACHINERY IMPORTERS.—The Federation of Construction Machinery Importers held a luncheon at the Dorchester Hotel on Wednesday, February 7th, at which the principal speaker was Mr. John W. Harriman, Deputy Chief of the Special Mission to the United Kingdom of the Economic Co-operation Administration. Mr. Harriman spoke of the importance of Anglo-U.S. co-operation, and of some of the activities of E.C.A., and Mr. R. G. Ledger, Chairman of the Federation, responded. The Federation has in its membership the principal importers in the United Kingdom of American heavy earth-moving and construction machines.

PETROLEUM INDUSTRY EXHIBITION.—Sponsored by the Shell Petroleum Company, Ltd., and the Anglo-Iranian Oil Company, Ltd., an exhibition including every aspect of the petroleum industry will be presented this summer. Sir Henry Tizard will open the exhibition, which will be at the Imperial College of Science and Technology, University of London, from April 6th to 21st. It will be at the Royal Technical College, Glasgow, from May 4th to 19th, at the University of Leeds from June 20th to July 6th, and at Cambridge University from July 16th to 28th.

EXPORT OF IRON AND STEEL GOODS.—The Board of Trade has announced that, as from February 12th, the export of iron and steel goods under open general licence is permitted only if the value exceeds the value of the iron or steel content, calculated at £21 per ton. This licence applies to iron and steel goods specified in Group 6 (2) of the first schedule to the Export of Goods (Control) (Consolidation) Order, 1950. Under a previous similar licence, which is revoked, the value was £16 16s. per ton. Exporters' inquiries regarding this licence should be made to the Export Licensing Branch, Board of Trade, Regis House, King William Street, London, E.C.4. (telephone, Avenue 3111).

MINING EXAMINATIONS RULES, 1951.—The Minister of Fuel and Power has approved the "Mining Examinations (Certificates of Competency) Rules, 1951," which will come into effect on April 1, 1951. The rules have been made by the Mining Qualifications Board, the body responsible for the conduct of these statutory examinations. One effect of the new rules is to abolish the oral examination altogether and to raise the qualifying standard in the written examination from 55 to 57·5 per cent of the maximum marks. At the same time, the right is reserved to call a particular candidate to appear before the examiners to be interviewed in relation to his written examination, if they should find this necessary to assist them in coming to a decision in his case. Copies of the rules may be purchased from H.M. Stationery Office, price 2d.

TUNGSTEN CARBIDE CUTTING TOOLS.—A short series of lectures on "The Manufacture, Design and Application of Tungsten Carbide Cutting Tools" will be held in the Polytechnic, Scarbrook Road, Croydon, on Mondays from 7 to 9 p.m. during next session. These lectures are intended to impart to suitably qualified personnel knowledge of the methods whereby tungsten carbide can be adapted to give best results on production work. The lectures will be illustrated by means of sound and strip film, and samples of material relating to each subject will be displayed. The lecturer will be Mr. F. H. Bates, Chief Education Officer of A. C. Wickman, Ltd., of Coventry. The dates and subjects of the lectures are as follows:—Monday, April 9th, "The Manufacture of Tungsten Carbide"; Monday, April 16th, "Designing of Standard and Special Tools and Cutters"; Monday, April 23rd, "Brazing Methods"; Monday, April 30th, "Grinding and Lapping"; Monday, May 7th, "Chipbreakers"; Monday, May 21st, "Application." The fee for the complete course will be £1 1s.

EXTENSION OF ST. ALBANS GAS WORKS.—The Eastern Gas Board has been informed by the Minister of Local Government and Planning and the Minister of Fuel and Power that a reduced scheme for the extension of the St. Albans Gas Works to meet the Gas Board's immediate needs is to be approved. The full-scale extension of the works originally proposed will not be approved and the Gas Board has been asked to make every effort to site the additional plant, which will ultimately be needed, elsewhere than at St. Albans. The plant and buildings which may be erected include one unit of coal carbonising plant with a daily capacity of 4 million cubic feet, as compared with the 12 million cubic feet capacity originally proposed; one modern unit of carburetted water gas plant, with a daily capacity of 2¼ million cubic feet, ; a gasholder of 1 million cubic feet capacity, as compared with the 2 million cubic feet capacity proposed, and the necessary tower purifiers. A number of conditions will be attached to the granting of permission for the works. The Gas Board must, after consultation with the Royal Fine Art Commission and the Local Planning Authority, obtain the approval of the two Ministers for the design and lay-out of the new buildings and plant. The existing horizontal retort house, which is old and in poor condition, is to be closed down and removed as soon as possible. A tree-planting scheme is to be carried out and the gasholders are to be painted in colours approved by the Local Planning Authority.

Personal and Business

SIR ROYDEN DASH has been appointed vice-chairman of Bracknell Development Corporation.

MR. A. W. MORRISON has been appointed a director of Powell Duffryn Carbon Products, Ltd., Hayes, Middlesex.

THE RAILWAY EXECUTIVE announces the appointment of Mr. J. W. Watkins as chief regional officer of the London Midland Region, British Railways.

THE BRITISH STEEL FOUNDERS' ASSOCIATION announces that its research and development division is now housed at Broomgrove Lodge, Broomgrove Road, Sheffield, 10.

MR. S. W. GOODEY has retired from the position of publicity manager of A.C.V. Sales, Ltd., Southall, Middlesex. He has been in the commercial vehicle industry for forty-one years.

DR. JOHN F. THOMPSON, president of the International Nickel Company of Canada, Ltd., has been elected chairman of the board in succession to the late Mr. R. C. Stanley.

MR. GILBERT T. BELL has been appointed managing director of Weldall and Assembly, Ltd., Stourbridge, which was recently acquired by Triplex Safety Glass Company, Ltd.

THE SOUTH WESTERN ELECTRICITY BOARD states that Mr. C. J. Hocking, M.I.E.E., has been appointed sub-area manager for Cornwall, in succession to Mr. A. C. Owen, who is retiring.

MR. J. G. JOHNSON has been appointed manager of the Manchester office of the Brightside Foundry and Engineering Company, Ltd. (Heating and Air Treatment Division), at Palatine House, 76, Victoria Street, Manchester, 3.

APPLIED HIGH FREQUENCY, Ltd., Coventry, announces the appointment of agents as follows: for Scotland, John S. Young and Co., Ltd., 257-261, Eglinton Street, Glasgow, C.5, and for South-West England and South Wales, Hocking and Orchard, Ltd., 90, Victoria Street, Bristol, 1.

DUNLOP, Ltd., states that Mr. E. H. Hurlston, superintendent of technical services at the Speke factory, has been appointed factory technical manager in Manchester. He is to be succeeded at Speke by Mr. W. A. Clarke, technical manager of the precision components department there.

MR. F. G. PENNY, M.I.C.E., M.I.Mech.E., has been appointed managing director of International Combustion (Holdings), Ltd., and of its subsidiary, International Combustion, Ltd., in succession to Sir George Usher, who has resigned that office. Sir George continues to serve as a director of both companies.

Launches and Trial Trips

PROVENCE, passenger and cargo liner; built by Swan, Hunter and Wigham Richardson, Ltd., for the Societe Generale de Transports Maritimes a Vapeur; length between perpendiculars 540ft, breadth moulded 73ft, depth moulded 34ft 7in, deadweight 8300 metric tons on 26ft draught; passengers, first-class 157, tourist 95, third-class 1052; two sets of triple-expansion, single-reduction geared Parsons turbines taking high-pressure superheated steam from three Babcock and Wilcox boilers, trial speed 20 knots. Trial, February 18th.

SHANKLIN, passenger ferry; built by William Denny and Brothers, Ltd., for British Railways, Southern Region; length overall 200ft, breadth moulded 46ft, draught 7ft, gross tonnage 965; two Denny-Sulzer diesel engines, eight cylinders, 950 b.h.p. each, 14¼ knots. Launch, February 22nd.

STAVIK, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for Aktieselskapet Hav and Aktieselskapet Havtank, Norway; length between perpendiculars 465ft, breadth moulded 63ft 6in, depth moulded 36ft 3in, deadweight 13,000 tons; Wallsend-Doxford oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, 3750 b.h.p. at 100 r.p.m. Launch, February 23rd.

Calendars and Diaries

WE acknowledge the receipt of calendars and diaries for 1951 from the undermentioned firms:—

WELLMAN SMITH OWEN ENGINEERING CORPORATION Ltd., Parnell House, Wilton Road, London, S.W.1.

DAVY AND UNITED ENGINEERING COMPANY, Ltd., Sheffield.

ANDERSON-GRICE COMPANY, Ltd., Taymouth Engineering Works, Carnoustie, Scotland.

PROPRIETORS OF HAY'S WHARF, Ltd., London Bridge, S.E.1.

British Patent Specifications

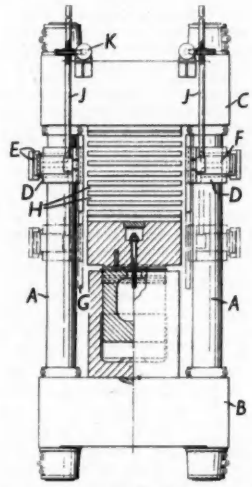
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

MACHINE TOOLS

649,579. May 23, 1947.—Improvements relating to Presses, John Shaw and Sons (Salford), Ltd., of Wellington Works, St. Stephen Street, Salford, 3, and John Bryan Shaw, of the company's address.

The multiple daylight press described has a vertically disposed press plate at each of two opposite sides of the assembly of daylights with means for advancing and retracting the plates, towards and away from the assembly. The plates and their thrust mechanisms are movable to a position, away from the edges, to leave the daylights accessible for cleaning. In the accompanying drawing, there is shown a multiple-daylight press, having four columns *A* between the upper and lower crossheads *B* and *C*. At each side of the press there is mounted on the respective pairs of

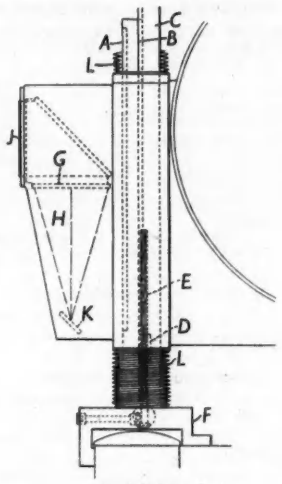


No. 649,579

columns a sliding frame or carrier member *D* having three hydraulic cylinders *E* and rams *F*, the rams at each side being provided with a vertical press plate *G* adapted to bridge the several daylights *H* and to engage any projecting member. Screw means are provided for raising and lowering the carrier members on the columns, the conduits and/or connections to and from the thrust cylinders *E* being flexible and of sufficient length to allow the desired up-and-down movements of the parts. The carrier screws comprise rods *J*, projecting upward from the carriers and passing through wormwheel nuts which are driven by worms on shafts from electric motors *K*, there being a separate motor for each side of the press. The single acting rams *F* are fitted with compression springs to effect their return movement. One cylinder *E* is located between the two columns at each side of the press.—*January* 31, 1951.

649,637. June 30, 1949.—Improvements relating to Horizontal Boring Machines, H. W. Kearns and Co., Ltd., of Atlantic Street, Broadheath, near Manchester, and Sir Henry Ward Lionel Kearns, C.B.E., of "Crossways," Groby Road, Altrincham.

This invention relates to means for measuring the vertical displacements of the spindle slides of horizontal boring machines. The spindle slide of a horizontal boring machine is provided with a measuring system, which comprises the illumination of a bar marked with a scale of distances, and an optical viewing system whereby the illuminated portion of the scale bar can be viewed in relation to a vernier scale, the scale bar and vernier being relatively displaceable. A transparent scale bar *A*, of less length than the total possible vertical displacement of the spindle slide, is mounted upright in a frame *B*, vertically displaceable along a supporting bar *C*, secured on the machine column by a dovetail guide groove. The frame is carried on a sleeve or nut D on a finely screw-threaded vertical feed screw *E* in a base plate *F* on the bed of the machine. This screw projects upwards at the side of the spindle slide column. The feed screw is rotated through a bevel gear by a horizontal shaft in the base plate. A milled headed set screw in the base plate bears against the lower end and locks the feed screw to prevent it being inadvertently turned. A translucent viewing screen *G* marked with a vernier scale is mounted horizontally in the upper end of a casing *H* secured to the spindle slide. The screen is viewed through a vertical window aperture *J*. At the lower end of the casing the scale



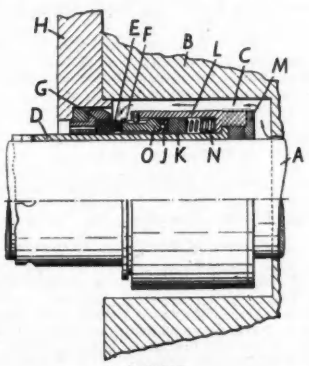
No. 649,637

bar is illuminated by an electric lamp, the beam from which, after passing through the transparent scale bar, is reflected laterally back by a pair of opposed mirrors. The beam, on leaving the scale bar, passes through an optical system, which, by a mirror *K* at the lower end of the casing, throws a magnified image of the illuminated portion of the scale on the bar opposite the optical system, on to the viewing screen. Displacements of the spindle slide along the column can thus be measured by observing the displacements of the image of the scale bar on the viewing screen. A bellows casing *L* extends upwards and downwards inside the casing to protect the screw.—*January* 31, 1951.

MISCELLANEOUS

649,863. August 24, 1948.—Improvements relating to Mechanical Sealing Devices between Rotary and Stationary Machine Parts, Crane Packing, Ltd., and Francis Clarence Walter Wilkinson, Slough, Buckinghamshire.

The accompanying drawing illustrates the invention as applied to the shaft of a high-pressure pump. The pump shaft *A* extends through the pump casing *B* in which a recess *C* is formed to house the components of the sealing device, the rotary members of which are carried on a sleeve *D* secure on the shaft. *E* and *F* are the intercontacing stationary and rotary annular sealing members. The stationary member *E* is fitted into a backing ring *G* mounted in an external end plate *H*. The rotary annular sealing member *F* is backed by a

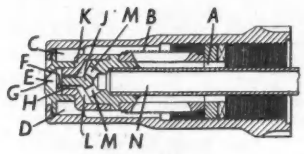


No. 649,863

U-shaped ring *J* and plain metal ring *K*. The three rings are housed within a cylindrical cover member *L*, which, together with an end cover plate *M*, are secured to the shaft. The three rings are urged towards the stationary member by a circular group of helical springs *N* seated in pockets in the cover member. The end *O* of the rotary sealing member is enlarged or rounded in section as shown, and its internal diameter is slightly less than that of the body portion of the member *F*. The U-shaped ring *J* is shaped to provide an annular cavity of part-circular section as a seating surface for the end *N*, and is preferably formed of resiliently flexible material, so that the member *F* is free to rock slightly out of coaxial alignment with the shaft and allow the intercontacting faces of the sealing members *E* and *F* to preserve good surface contact.—*February* 7, 1951.

649,970. June 22, 1948.—Improvements in Liquid Fuel Burners, Dowty Equipment, Ltd., of Arle Court, Cheltenham, and Oscar Hahn, of the company's address.

The invention seeks to provide an improved "spill" burner whereby maximum atomisation efficiency, and smoothness of control of returning fuel may be attained, together with avoidance of aeration of returning fuel. The construction of a spill burner according to the invention is shown in the accompanying drawing. An annular supply duct *A* conducts fuel through a filter *B* into spaces *C* and *D*, from which the fuel enters a swirl chamber *E* through tangential passages *F*. The swirl chamber converges at its outer end to a circular discharge orifice *G*, and at its other end has a substantially flat end wall in which is formed a spill orifice *H* comprised by the annular space between an inner



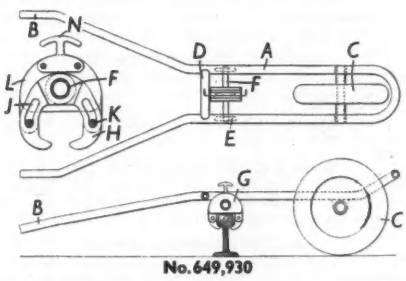
No. 649,970

member *J* and an outer member *K*. The spill orifice leads rearwards into an annular diffusing chamber *L* of increasing diameter. The member *J* has a number of holes *M* through which the fuel can leave the diffusing chamber to enter a spill or return line *N*. The projection of the part *J* within the spill orifice is thus supported beyond the diffusing chamber. In operation, fuel entering the swirl chamber through the tangential passages sets up a swirling motion. If there is no resistance in the spill line *N*, the mass of fuel will leave the swirl chamber through the annular spill orifices *H* and pass off through the diffusing chamber and through the holes into the spill line. If there is some resistance to return flow, some of the fuel in the swirl chamber will pass through the discharge orifice *G* to form a finely atomised conical spray.—*February* 7, 1951.

RAILWAY ENGINEERING

649,930. March 10, 1948.—Portable Rail-Handling Appliance for Lifting and Placing Railway Track Rails, Eric James Pannell, 23, Lynwood Avenue, Slough, Buckinghamshire, and Edward Hales Tustain, Vandon Court, Petty France, Westminster, London, S.W.1.

In the present method of lifting and placing railway rails the rails are handled by means of pairs of tongs with two men, one on either side of the rail, handling each pair and with five or six pairs of tongs per rail of 60ft length. The invention provides an improved appliance which replaces the tongs and which permits the rails to be handled by a smaller number of men. As illustrated in the



No. 649,930

accompanying drawings, the appliance consists of a narrow tubular framework *A* with handles *B* at one end and with a wheel *C* at the other. The frame is stiffened by a cross bar *D*. On lugs *E* welded to the framework is secured a second cross bar *F* on which is mounted a lifting hook *G*. It comprises a pair of jaws *H* with shaped slots *J* engaged by pins *K* in a yoke *L* fitting over the cross bar and embracing the jaws. The yoke is fitted with a handle *N*. On lowering the jaws of the hook over the head of a rail they ride over the rail, open and of their own weight close to grip the rail. To release the jaws a handle is raised and the pins on the yoke spread the jaws apart.—*February* 7, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Association of Supervising Electrical Engineers

To-day, Mar. 9th.—BRISTOL BRANCH: Grand Hotel, Bristol, "Floodlighting," R. S. Hazell, 7.30 p.m.——CREWE BRANCH: Crewe Arms Hotel, Crewe, "Illumination Design," S. D. Pryor, 7.30 p.m.——NOTTINGHAM BRANCH: Electricity Showrooms, Smithy Row, Nottingham, "Automatic Sequence Control of Conveyors and Belt Protection," T. A. Peat, 7.30 p.m.

Tues., Mar. 13th.—BOLTON BRANCH: York Cafe, Great Moor Street, Bolton, "Thermal Storage Heating," Mr. Good, 7.15 p.m.——S.W. LONDON BRANCH: St. George's Hall, St. George's Road, Wimbledon, "Corrosion," G. E. D. Redman, 8.15 p.m.

Wed., Mar. 14th.—BIRMINGHAM BRANCH: Chamber of Commerce, New Street, Birmingham, "A.C. Commutator Machines," 7 p.m.——BRADFORD BRANCH: Midland Hotel, Bradford, "The Application of Refrigeration," E. Hargreaves, 7.30 p.m.——KENT BRANCH: County Hotel, Canterbury, "The Testing of the Earth and its Resistivity," H. Coulls, 8 p.m.

Sat., Mar. 17th.—OXFORD BRANCH: Southern Electricity Board's Demonstration Room, George Street, Oxford, "Ventilating," 2.30 p.m.

Chemical Society

Thurs., Mar. 15th.—Burlington House, Piccadilly, London, W.1, meeting for the reading of original papers, 7.30 p.m.

Diesel Engine Users Association

Thurs., Mar. 15th.—Caxton Hall, Westminster, S.W.1, "Operating Experience with a 750kW Industrial Gas Turbine," G. B. R. Feilden, 2.30 p.m.

Engineer Buyers' and Representatives' Association

Fri., Mar. 16th.—Works visit to Flower's Brewery, Stratford-on-Avon, 2 p.m.

Illuminating Engineering Society

To-day, Mar. 9th.—BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham, annual general meeting, "Light and Vision," H. C. Weston, 6 p.m.

Tues., Mar. 13th.—66, Portland Place, London, W.1, "The Lighting of Buildings," W. A. Allen and R. G. Hopkinson, 6 p.m.——STOKE-ON-TRENT GROUP: 31, Kingsway, Stoke-on-Trent, "Illumination and Illusion," P. Hartill, 6 p.m.

Thurs., Mar. 15th.—GLOUCESTER AND CHELTENHAM CENTRE: Cadena Cafe, High Street, Cheltenham, "Hospital Lighting," D. J. Reed, 6.30 p.m.——BRADFORD GROUP: 45–53, Sunbridge Road, Bradford, "Fluorescent Lamps—Facts and Faults," T. C. Holdsworth, 7.30 p.m.

Incorporated Plant Engineers

Tues., Mar. 13th.—E. LANCASHIRE BRANCH: Engineers' Club, Albert Square, Manchester, "Installation and Maintenance of Fluorescent Lighting in Industry," F. C. Tyrrell, 7.15 p.m.

Wed., Mar. 14th.—E. MIDLANDS BRANCH: Welbeck Hotel, Nottingham, annual general meeting, 7 p.m.

Thurs., Mar. 15th.—LIVERPOOL AND N. WALES BRANCH: Radiant House, Bold Street, Liverpool, annual general meeting, 7 p.m.

Institute of British Foundrymen

Sat., Mar. 10th.—NEWCASTLE-UPON-TYNE BRANCH: Neville Hall, Westgate Road, Newcastle-upon-Tyne, Reports of Sub-Committee T.S. 23, "Repair and Reclamation of Grey Iron Castings by Welding and Allied Methods," 6 p.m.——SCOTTISH BRANCH: Royal Technical College, Glasgow, "Patternmaking as an Aid to Production, Moulding and Core Making," S. A. Horton. Annual business meeting, 3 p.m.—W. RIDING OF YORKSHIRE BRANCH: Technical College, Bradford, "Some Notable Aluminium Alloy Castings," A. R. Martin, 6.30 p.m.

Institute of Economic Engineering

Fri., Mar. 16th.—George Hotel, Kingsbury, "The Punched Card System and its Application to Management," John Wm. Parker, 7 p.m.——Engineers' Club, Albert Square, Manchester, "Education for Management," H. E. Kearsey, 7.30 p.m.

Institute of Industrial Administration

Wed., Mar. 14th.—School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, "Personnel Relations Services," H. Briggs, 7 p.m.

Institute of Industrial Supervisors

Tues., Mar. 13th.—DUDLEY AND DISTRICT SECTION: Technical College, Dudley, "The Foreman and the Factories Act," R. M. Wickenden, 7.30 p.m.

Thurs., Mar. 15th.—BRISTOL SECTION: Central Hall, Oldmarket, Bristol, "Some Managerial Problems." D. M. G. Sneddon, 7.30 p.m.——COVENTRY SECTION: Geisha Cafe, Hertford Street, Coventry, "The Foreman and the Cost Office," F. B. Anscombe, 7.30 p.m.

Institute of Marine Engineers

Tues., Mar. 13th.—85–88, The Minories, London, E.C.3, "Gamma Radiography in Shipbuilding and Engineering," J. D. Hislop, 5.30 p.m.

Institute of Navigation

Fri., Mar. 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Applications of Oceanographical Research to Navigation," G. E. R. Deacon, 5 p.m.

Institute of Road Transport Engineers

To-day, Mar. 9th.—S. WALES GROUP: S. Wales Institute of Engineers, Park Place, Cardiff, open discussion meeting, 7 p.m.

Institution of Physics

Tues., Mar. 13th.—47, Belgrave Square, London, S.W.1, "Plasma Oscillations," D. Gabor, 5.30 p.m.

Fri., Mar. 16th.—47, Belgrave Square, London, S.W.1, "The Physics of Radiography," H. S. Peiser, 6.30 p.m.

Institute of Road Transport Engineers

Tues., Mar. 13th.—E. MIDLANDS CENTRE: Engineers' Institute, Nottingham, "Springs and Suspensions for P.S. and Commercial Vehicles," J. A. Birdsell, 7.30 p.m.

Wed., Mar. 14th.—N.W. CENTRE: Adelphi Hotel, Liverpool, "Brakes and Clutches," Ivan M. Waller, 7 p.m.

Thurs., Mar. 15th.—Royal Society of Arts, John Adam Street, London, W.C.2, "The Use of Lightweight Sandwich Materials for the Construction of Road Transport Vehicles," F. C. Lynam, 6.30 p.m.——N.E. CENTRE: Hotel Metropole, Leeds, "The Testing and Development of Commercial Vehicles," J. Alden, 7 p.m.——SCOTTISH CENTRE: North British Hotel, Edinburgh, "The Servicing of Brakes," J. W. Kinchin, 7.30 p.m.

Institution of Chemical Engineers

Sat., Mar. 10th.—N.W. BRANCH: The University, Liverpool, "The Reactivation of Bone Charcoal," W. L. Howe and A. M. Moult, 2.30 p.m.

Institution of Civil Engineers

Tues., Mar. 13th.—Great George Street, Westminster, S.W.1, "The Design and Construction of the Royal Festival Hall, South Bank," E. O. Measor and D. H. New, 5.30 p.m.

Wed., Mar. 14th.—MIDLANDS ASSOCIATION: The College, Loughborough, film on "Roads," 7 p.m.

Thurs., Mar. 15th.—N.W. ASSOCIATION: Engineers' Club, Albert Square, Manchester, "Traffic Control," L. P. F. Hubbard, 6.30 p.m.

Institution of Electrical Engineers

Mon., Mar. 12th.—Savoy Place, Victoria Embankment, W.C.2, discussion on "Electronic Power Control of Motors," opened by E. W. Forster, 5.30 p.m.——N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne, "Standardisation and Simplification in the Electrial Industry," J. T. Moore; "An Organisation for Internal Standardisation in a Large Electrical Manufacturing Company," P. J. Daglish, 6.15 p.m.

Tues., Mar. 13th.—MEASUREMENT AND RADIO SECTIONS: Savoy Place, Victoria Embankment, W.C.2, "The Testing of Fine Wires for Telecommunication Apparatus," R. C. Woods and J. K. Martin; "The Use of an Electrostatic Wattmeter for Magnetic Loss Measurements," J. K. Choudbury and Arvon Glynne, 5.30 p.m.

Wed., Mar. 14th.—SCOTTISH CENTRE: Heriot-Watt College, Edinburgh, "Recent Developments in Comparative Methods of Testing A.C. Electricity Meters," S. F. Musson and R. E. Mell, 7 p.m.——LONDON STUDENTS' SECTION: Savoy Place, Victoria Embankment, W.C.2, Problems Night, 7 p.m.

Thurs., Mar. 15th.—UTILISATION SECTION: Savoy Place, Victoria Embankment, W.C.2, "Transients in Electric Mine Winders and Their Effects on Rope Stresses," T. H. Petch, 5.30 p.m.——N. MIDLAND CENTRE: 24, Aire Street, Leeds, "The Organisation of Laboratory Work," E. C. Walton, 6 p.m.

Institution of Engineering Inspection

Tues., Mar. 13th.—COVENTRY SECTION: Technical College, Coventry, "Zinc Alloy Die Castings," Ronald W. Bailey, 7.30 p.m.

Thurs., Mar. 15th.—SHEFFIELD BRANCH: Grand Hotel, Sheffield, "Plastics—with Special Reference to Engineering Applications," E. M. Elliott, 7 p.m.

Institution of Heating and Ventilating Engineers

Tues., Mar. 13th.—S.W. BRANCH: General Electric Company, Ltd., Cathays Park, Cardiff, "Further Aspects of Air Conditioning," A. Warner, 6.30 p.m.

Wed., Mar. 14th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Heating Research in Occupied Houses," J. C. Weston, 6 p.m.——LIVERPOOL AND DISTRICT BRANCH: Radiant House, Bold Street, Liverpool, "Steam Distribution Problems," H. F. Simpson, 6.30 p.m.

Thurs., Mar. 15th.—BIRMINGHAM AND DISTRICT BRANCH: Imperial Hotel, Temple Street, Birmingham, "Refrigeration with Special Reference to Air Conditioning," F. L. Pettman, 6.30 p.m.

Institution of Mechanical Engineers

To-day, Mar. 9th.—Storey's Gate, St. James's Park, S.W.1, "Further Mechanical Aids for the Foundry," A. S. Beech, 5.30 p.m.—N.E. BRANCH, GRADUATES' SECTION: Head, Wrightson and Co., Ltd., Eaglescliffe Foundry, Yarm Road, Stockton-on-Tees, "The Manufacture of Mineral-Insulated, Copper-Covered Cables—Some Engineering Aspects," G. P. Fyson, 7 p.m.

Mon., Mar. 12th.—BIRMINGHAM A.D. CENTRE: Chamber of Commerce, New Street, Birmingham, "The Supercharging of Internal Combustion Engines," E. N. Soar, 6.45 p.m.——LUTON A.D. CENTRE: Town Hall, Luton, "The Development of the De Havilland Series of Engines for Light Aircraft," J. L. P. Brodie, 7.15 p.m.

Tues., Mar. 13th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, S.W.1, "The Use of Wire Resistance Strain Gauges in Automobile Engineering," J. R. Bristow, P. Metcalf and C. H. G. Mills, 5.30 p.m.——S. WALES BRANCH: Westgate Hotel, Newport, "The Design and Operation of a Large Heat Transfer Installation," N. Brearley, 6 p.m.

Wed., Mar. 14th.—SOUTHERN BRANCH, GRADUATES' SECTION: Technical College, Brighton, "Administration in Engineering," P. K. Digby, 7 p.m.——WESTERN BRANCH, GRADUATES' SECTION: College of Technology, Unity Street, Bristol, "Electrical Resistance Strain Gauges," K. P. Taylor, 7 p.m.——NORTH-WESTERN A.D. CENTRE: Grosvenor Hotel, Chester, "Wear of Fuel Injection Equipment and Filtration of Fuel for Compression-Ignition Engines," A. E. W. Austen and B. E. Goodridge, 7.15 p.m.

Thurs., Mar. 15th.—E. MIDLANDS BRANCH, PROVISIONAL GRADUATES' SECTION: School of Art, Green Lane, Derby, "Aspects of Railway Development on Western and Midland Regions," J. K. Williams and L. Roberts, 7 p.m.——MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Assembly Processes—Their Choice and Development," J. L. Miller, 6 p.m.

Fri., Mar. 16th.—Storey's Gate, St. James's Park, S.W.1, "Pipe Joints for Hydraulic Power Transmission," B. Cooke, 5.30 p.m.

Institution of Production Engineers

Sat., Mar. 10th.—YORKSHIRE GRADUATE SECTION: Great Northern Station Hotel, Leeds, 1, "Foundry Production Problems in Relation to Casting Design," A. E. McRae-Smith, 2.30 p.m.

Mon., Mar. 12th.—SHEFFIELD SECTION: Royal Victoria Station Hotel, Sheffield, "Modern Methods of Railway Laminated Spring Manufacture," R. Fielding, 6.30 p.m.——DERBY SUB-SECTION: School of Art, Green Lane, Derby, annual general meeting, "Noise and Vibration in Machinery," W. A. Tuplin, 7 p.m.—HALIFAX SECTION: White Swan Hotel, Halifax, "The Effects of Costs on Production Engineers," F. M. W. Hird, 7.15 p.m.——YORKSHIRE SECTION: Hotel Metropole, King Street, Leeds, 1, annual general meeting, 7 p.m.

Tues., Mar. 13th.—MANCHESTER GRADUATE SECTION: College of Technology, Sackville Street, Manchester, annual general meeting, 6.45 p.m.; film show, 7.15 p.m.——BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, annual general meeting and Chairman's Address, N. Newey, 6.45 p.m.——DUNDEE SECTION: Mather's Hotel, Whitehall Crescent, Dundee, "Planning for Production incorporating Cost Control," C. W. Higgins, 7.30 p.m.

Wed., Mar. 14th.—EDINBURGH SECTION: North British Station Hotel, Edinburgh, "Some Applications of Rubber in Engineering," G. W. Trobridge, 7.30 p.m., followed by the annual general meeting.——LIVERPOOL SECTION: Radiant House, Bold Street, Liverpool, "Laboratory Control in Production Engineering," J. Pardoe, 7.15 p.m.——N. IRELAND SECTION: Municipal College of Technology, Belfast, annual general meeting, 7.30 p.m.——PRESTON SECTION: Harris Institute, Corporation Street, Preston, "Industrial Machine Maintenance," R. M. Buckle, 7.15 p.m.——WESTERN SECTION: Grand Hotel, Broad Street, Bristol, "Industrial Applications of the Lost Wax Process," A. Short, 7.15 p.m.

Thurs., Mar. 15th.—LEICESTER SECTION: College of Art and Technology, The Newarke, Leicester, annual general meeting and Section President's Address, 6.30 p.m.——GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Use of Rubber as an Engineering Material," G. W. Trobridge, 7.30 p.m.——WOLVERHAMPTON GRADUATE SECTION: W. Midland Gas Board, Darlington Street, Wolverhampton, "Pressure Die Casting in Zinc-Base and Aluminium Alloys," A. Munslow, 7.30 p.m.

Fri., Mar. 16th.—E. COUNTIES SECTION: Public Library, Ipswich, annual general meeting, 6.30 p.m., followed by "Noise and Vibration in Machinery," W. A. Tuplin.——N.E. GRADUATE SECTION: Neville Hall, Westgate Road, Newcastle-upon-Tyne, "Work Measurement," W. K. Hall, 7 p.m.

Junior Institution of Engineers

To-day, Mar. 9th.—39, Victoria Street, London, S.W.1, "Glass, Light and Designs," J. G. Holmes, 6.30 p.m.

Fri., Mar. 16th.—39, Victoria Street, London, S.W.1, "Steam Locomotive as a Vehicle," C. R. H. Simpson, 6.30 p.m.——SHEFFIELD AND DISTRICT SECTION: Grand Hotel, Sheffield, "Notes on the Exploitation of Water Power," W. H. Bailey, 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Mar. 9th.—Neville Hall, Newcastle-upon-Tyne, "The Application of Statistical Methods to the Analysis of Service Performance Data," J. W. Bonebakker, 6.15 p.m.

Royal Aeronautical Society

Thurs., Mar. 15th.—Institution of Civil Engineers, Great George Street, Westminster, S.W.1, "Progress Towards Serviceability," H. G. Conway and R. H. Bound, 6 p.m.

Stephenson Locomotive Society

Mon., Mar. 12th.—32, Russell Road, Kensington, W.14, "Progress and Problems of British Railways," D. S. Barrie, 6.30 p.m.——N.W. AREA: Central Station Offices, Liverpool, "Crewe, 1903–9," W. H. Wright, 7 p.m.

Women's Engineering Society

Wed., Mar. 14th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "General Rubber Products," W. Holland-Bowyer, 6.30 p.m.

Contracts

THE BURNTISLAND SHIPBUILDING COMPANY, Ltd., has received an order from the Compania de Navegacion Oriental de Panama to build a motor cargo liner of 10,500 tons deadweight. The propelling machinery of 4000 b.h.p. will be constructed by Sulzer Brothers, Ltd., Winterthur, Switzerland.